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THE EXAMINER'S FUNCTION

Mixed-Pressure Turbo-Generator Installation

By T. W. Reed

SYNOPSIS—As a result of installing a mixed-pressure steam turbine, 300 kw. additional capacity was obtained from exhaust steam which had previously been exhausted to the atmosphere. This gain was obtained without additional labor or operating costs.

By installing a turbo-generator in the power plant of Arbuckle Brothers, sugar refiners and coffee roasters, it has again been proved that great advantage is derived from the use of this type of turbine in the industrial plant as a recoverer of waste steam, thus increasing the generating capacity without increasing the coal consumption and obtaining improved overall plant economy.

This power plant is located on the Brooklyn side of the East River and on the water front, a short distance north of the Brooklyn Bridge. During the year 1912, it was deemed advisable to increase the maximum capacity of the plant, and, at the same time, always have a spare unit in reserve. After careful consideration by the purchaser's engineers as to the best method of increasing the capacity and to determine what economies could be effected, a turbo-generator was recommended and purchased.

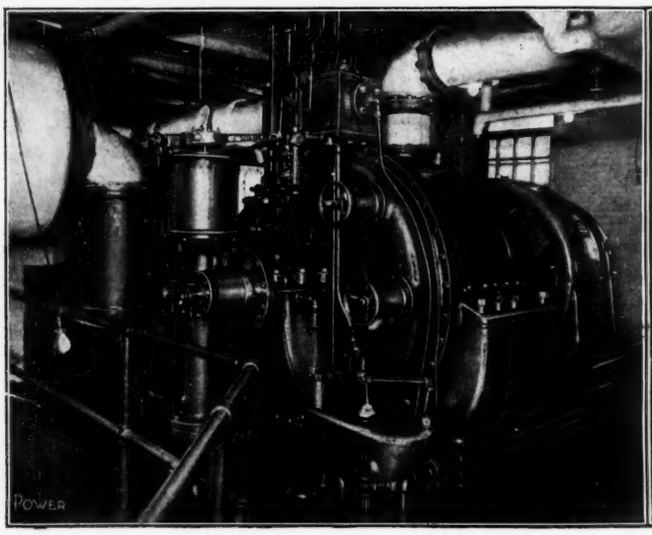

Fig. 1. Steam End of Mixed-Pressure Unit

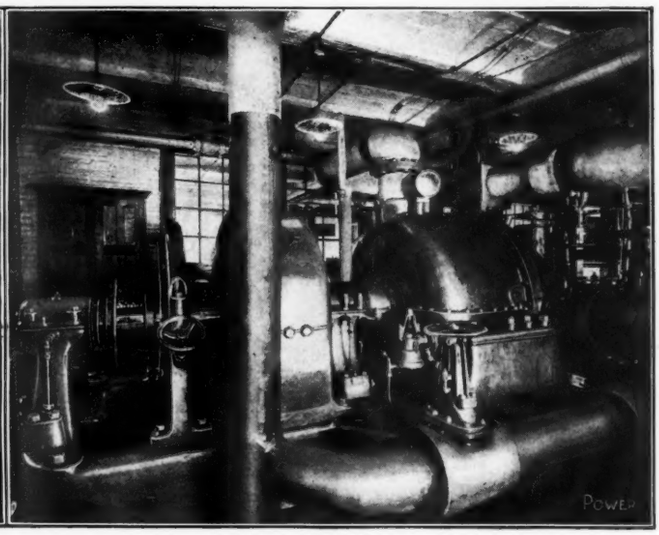

Fig. 2. Generator End of Mixed-Pressure Turbine

The turbine, Fig. 1, is of the Curtis horizontal-shaft, mixed-pressure type. It is directly connected to a 300-kw., direct-current, 250-volt generator, Fig. 2. This unit utilizes the exhaust steam from reciprocating engines and auxiliary apparatus that is in excess of steam required about the plant for manufacturing purposes and steam heating. This type of turbine is particularly well adapted for the industrial plant where the low-pressure steam supply is a variable one, inasmuch as it can operate entirely on low-pressure steam or with a partial supply of low-pressure and high-pressure steam, or entirely on high-pressure steam, developing its full rated capacity under either condition with good economies.

Low-pressure steam is supplied at approximately 7 lb. gage pressure, and is controlled by a butterfly valve in the low-pressure line. The mixed-pressure feature consists of a separate set of high-pressure admission valves, which control the admission of high-pressure steam through a separate set of nozzles which are correctly proportioned to handle the steam at 130 lb. gage pressure. By this scheme of utilizing the high-pressure steam considerable better economy is obtained than by the use of a reducing valve. The admission of steam to either the low- or high-pressure element of the turbine is controlled by one governor, thereby obtaining close speed regulation for any condition of load or a variable supply of low-pressure steam.

The unit as a whole is very compact. The oiling system is entirely automatic, and a few drops of oil are applied once or twice a day to the transmission bearing of the governor.

The original power equipment of this plant consisted of four 300-kw. and one 150-kw. generators, which are direct connected to simple noncondensing engines. These engines, and all auxiliary machinery, including boiler-feed pumps and large salt-water circulating pumps, which are used for vacuum pans, exhaust into a common steam header against a back pressure which averages between 8 and 10 lb.

Steam from this header is drawn off and distributed throughout the plant, where it is used in the vacuum pans for boiling sugar, evaporators, heating water and building heating, the surplus steam above plant requirements being used in the turbine.

The problem of installing the turbo-generator was a simple one, and as the floor space required is small as compared to units of the same capacity in the plant, the turbine and generator were placed in one corner of the engine room.

Neither the original exhaust-steam piping nor headers required any marked change to make the low-pressure steam connections to the turbine. The connection between the steam header and low-pressure inlet to the turbine consists of a lagged pipe line approximately 75 ft. long. Between the common exhaust-steam header and the low-pressure line to the turbine a regulating valve is in-

stalled, which maintains a constant pressure at the turbine of approximately 7 lb. gage. There is installed in the low-pressure line, just ahead of the butterfly valve, which controls the admission of low-pressure steam, a Cochrane steam separator of sufficient capacity to supply dry steam to the turbine.

The top of the turbine foundation is at the level of the engine-room gallery floor. This level was used to gain the necessary head room for the condensing equipment without going to any greater depth than that of the original basement floor. Because of the short distance to the river, excellent results have been obtained with the condensing equipment, and during the winter season, when the temperature of injection water is low, the vacuum has averaged very close to 29 in., measured on the mercury column and corrected to 30 in. barometer.

The condensing equipment is of the low-head jet type; the condenser cone, circulating pump and air pump are all mounted on a common bedplate and driven by a steam turbine, the exhaust from this turbine being so arranged that it can be taken into the low-pressure turbine or carried to the feed-water heater.

The turbo-generator operates in multiple with the engine-type generators, and the combined capacity of the equipment is used for driving motors throughout the sugar and coffee houses, and also furnishes lighting for the office and plant buildings. The unit operates continuously 24 hours per day, six days per week, and the load averages very close to its rated capacity.

No test has been made to date to determine just what the overall economy of the plant is since the installation of the turbo-generator, but benefits that have been derived from the installation can be briefly summed up as follows: 300 kw. additional capacity is obtained from the low-pressure steam, which, in the past, had gone to waste; no additional labor or operating cost; no additions to building or boiler capacity; better operation of reciprocating engines, as a constant back pressure can be maintained, thereby allowing for closer setting of the engine valves, resulting in much smoother operation.

Tom Hunter, Hoisting Engineer

By Warren O. Rogers

SYNOPSIS—In which Hunter explains something about centrifugal pumps for mine service, and we visit a mine to see one in operation. Upon emerging we come upon a vast culm pile, at one time thought of no value.

A few days after my last interview with Hunter I strolled down to the depot to watch the trains come and go. While comfortably seated on a baggage truck, my idle musings, as to where all the travelers were going, were interrupted by a terrific slap on the back, the force of which knocked a partly consumed cigar onto the coal-dust-covered platform.

Turning, I found my assailant was Hunter, who was going about 30 miles down the line, and as he extended an invitation to go with him, I gladly accepted. After getting comfortably seated in the train the conversation drifted from one topic to another, until Hunter mentioned that he was going to witness the operation of a motor-driven centrifugal pump. That was my chance.

"Can centrifugal pumps be used to advantage in mines?" I asked, "if so, why haven't we seen them in the mines we have visited?"

"Because most of the mines have been steam propositions from the start and it would mean a large financial outlay to change over to electricity. Mines having alternating-current generating machines will be found to have part, if not all, of the pump equipment of the centrifgugal type. After you have seen one of these units running you will understand that it is a comparatively simple machine, having no valves to keep in repair and will pass a large amount of water, in fact, it will deliver the same amount of water under the same conditions of head as the reciprocating pump, and use less fuel to produce the power."

"Isn't the speed at which the pump runs a factor against its use?" This question was asked because I had visions of a motor driving a pump at high velocity.

"The revolution of a pump is dependent on the head against which it operates, as is also its capacity, for a few revolutions faster or slower will considerably vary the amount of water delivered. It won't do to overspeed a pump and the best results are obtained when the velocity through the discharge is between 8 and 12 ft. per sec. If the pump is crowded beyond, the tendency is toward less efficiency."

"How much lift can be given to a centrifugal pump, and how do you get the water started in them?"

Hunter flicked the ashes from the end of his cigar and said: "It will lift water by suction as high as any pump, but there must be no air leaks in the suction pipe, as a small amount of air will affect the working of the pump and sometimes prevent the discharge of any water.

"As with any other type of pump, it should be placed as close to the sump as possible, and never more than 24 ft. above the surface of the water to be pumped; 20 ft. would be a better maximum lift.

"A mistake is sometimes made by using piping smaller than the inlet and discharge orifices, and, of course, the less elbows and bends in the pipe the better. In case the discharge pipe is long, one or two sizes of pipe larger than called for would be of advantage. Now for your second question.

"All centrifugal pumps placed above the water supply must be primed before starting. Some pumps are made with a priming device or ejector. Steam is turned on and the suction created draws the air out of the suction pipe, when water will rise in it to the pump. If the suction pipe has a foot valve, the pump can be filled with water by means of pails or by other available means. In some cases a small motor-driven pump is used for priming.

"When this type of pump is used for mine work where the head is necessarily high, a multistage unit is used, with as many stages as may be necessary to elevate the water to the surface."

"Now just hold up a little and tell me what a multistage pump is, before you go on any further," and

I handed Hunter a "Lord Somebody" to keep him sociable.

"Simply two or more single pumps combined within one casing," replied Hunter, lighting the weed. "The water is delivered from the runner of one pump to the runner of the second, and so on through the total number of stages and the pressure produced increases in proportion. Every pump should be designed for each individual case, as for any desired capacity, head and speed, to obtain the best results. The efficiency varies with the size of the unit, the average for medium-size pumps being from 60 to 65 per cent. Large pumps are rated as high as 80 per cent. efficiency.

"Like everything else this type of pump is made good, poorly and indifferently. The better-class pumps have shrouded impellers."

"Shrouded impeller, what do you mean by that?"

"Why the metal is carried up on each side of the impeller so that there will be no loss from friction of the rotating water against the inside of the pump casing. Naturally a thin film of water will exist between the outside surface of the shrouds and the inside of the pump

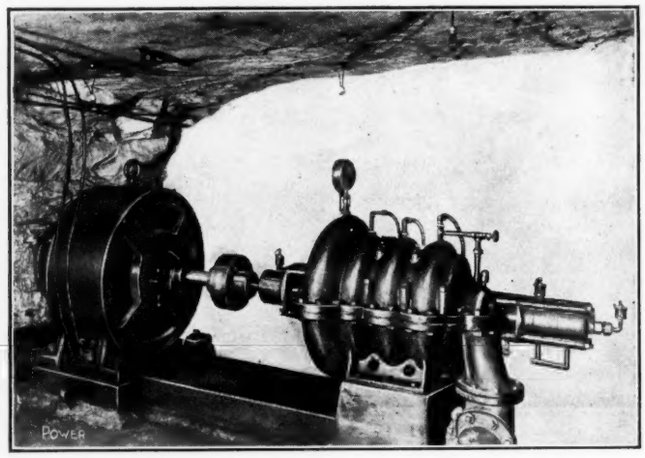

FIG. 1. MOTOR-DRIVEN, FOUR-STAGE CENTRIFUGAL PUMP. CONCRETE WALL IN THE BACKGROUND

casing. This, however, can be reduced to a minimum if the outside of the impeller and inside casing are machined."

"Then, as I understand, only such mines as are electrically equipped operate centrifugal pumps, and that is why we haven't seen more of them."

"Now don't jump at conclusions before you know where you are going to land," rejoined Hunter. "The centrifugal pump is a comparatively recent product and because other types of pump have for years been doing the work satisfactorily, there are those who do not look upon it with favor for underground use. Others, however, have looked into the merits of centrifugal pumps and back their belief by operating them. Most are motor driven for several reasons, but that is a cat of another color."

"That means," said I, "that those who do not favor centrifugal pumps are prejudiced against them."

"Yes and no, because the service of the pump depends somewhat upon the shape and size of the impeller passages and the amount and size of foreign matter, such as chips, coal and small pieces of rock which are likely to be picked up by the suction and pass through the pump.

"As I told you some time ago, pumps handling mine water must be protected from the acids by suitable linings, although a few mines are fortunate in having water that does not attack the metal of the pump."

"Well, you said that most mine pumps are wood lined; why can't the same thing be done with centrifugal pumps?"

"It would not be practicable to use wood because of mechanical and operating conditions, but all parts com-

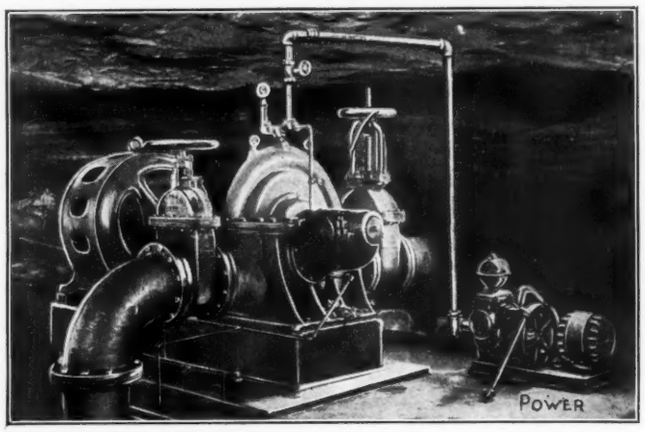

FIG. 2. CENTRIFUGAL PUMP AND PRIMING OUTFIT

ing in contact with the water can be made of bronze, which will resist the corrosive action of the water."

Just then the train slowed down at our destination, and a few minutes later we were down in the mine pump room, where I first saw a motor-driven, four-stage centrifugal mine pump. It had a capacity of 800 gal. of water per min. with a 640-ft. lift, Fig. 1. Later on in the day I saw a second, but smaller single-stage pump and priming outfit, Fig. 2. It was working against a low head and was driven by an induction motor. The priming plunger pump was driven by a small 2-hp. motor.

Coming up out of the second mine into daylight the view was one not often seen. Tons upon tons of culm

FIG. 3. WE LOOKED DOWN UPON A VAST FIELD OF CULM AND MINE REFUSE

and mine refuse partly filled the valley below the mine shaft, Fig. 3. At the far end of the culm pile a small washery was reclaiming fuel from the pile of refuse that had been thought of no value when taken from the mine. In the distance the village of miners' houses could be seen, toward which we made our way, over the mass of dirt, coal and slate. A train soon brought us back to our starting point, where we parted for the night.

The Theory of Centrifugal Pumps

By R. L. Daugherty*

SYNOPSIS—The various divisions of head entering into the operation of a centrifugal pump, and the characteristics of both turbine and volute pumps.

Centrifugal pumps are so called because centrifugal force or the variation of pressure due to rotation is an important factor in their operation. However, as will be shown later, there are other factors which enter into their operation. Centrifugal pumps are broadly divided into two classes: Turbine pumps and volute pumps.

In the turbine pump the impeller is surrounded by a diffusion ring containing diffusion vanes, whose function

Fig. 1. Casing Surrounding Diffuser

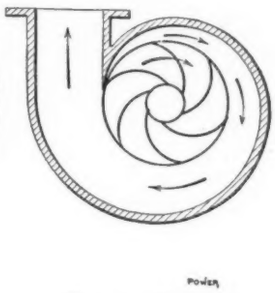

Fig. 2. Volute Casing

is to gradually reduce the velocity of the water leaving the impeller and thus efficiently transform the kinetic energy into pressure energy. The casing surrounding the diffuser may be either circular, as shown in Fig. 1, or it may be of a spiral form.

The volute pump has no diffusion vanes, but, instead, the impeller is surrounded by a casing of spiral form. (See Fig. 2.) This spiral is known as the volute, from which the pump receives its name. Some pumps may have a circular instead of a volute casing, but, as this type is less efficient, it will not be considered in the classification.

By many, the term "centrifugal pump" is understood to mean a pump without diffusion vanes, while one with diffusion vanes is called a turbine pump. The writer, however, prefers to use the term in its broader sense so as to cover both types.

Head or Lift

In all cases the head developed is the vertical height to which the water is lifted, plus the velocity head at discharge, plus all losses in the suction and discharge pipes. It is also the difference between the total head on the discharge and the suction sides of the pump. If pressure and vacuum gages are used to determine this, then the head developed equals the pressure-gage reading (in feet of water) plus the vacuum-gage reading (in feet of water), plus the difference in elevation of the centers of the gages, plus the velocity head in the discharge pipe, minus the velocity head in the suction pipe.

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Head of Impending Delivery

The head developed by the pump when no discharge occurs is called the "shutoff head" or the "head of impending delivery." We are then concerned only with "centrifugal head" or the height of a column of water sustained by centrifugal force. If a vessel containing water is rotated at a uniform rate the water will tend to rotate at the same speed and the surface will assume a curve as shown in Fig. 3. This curve approximates a parabola, and

$$h = u^2_2 / 2g$$

where u_2 = Linear velocity of the vessel at a radius, r_2.

If the water be inclosed so that its surface cannot change, the pressure will follow the same law. If, as in Fig. 4, the water is set in motion by a paddle wheel in a chamber and a pressure chamber surrounds that containing the water in motion, then the pressure in the outer chamber will be greater than that at the center by the amount $u^2_2/2\,g$.

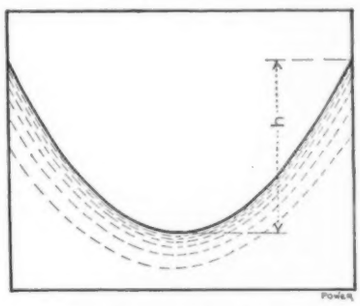


Fig. 3. Parobolic Form of Water Surface

Although ideally the head of impending delivery equals $u^2_2 / 2g$, pumps give values either above or below

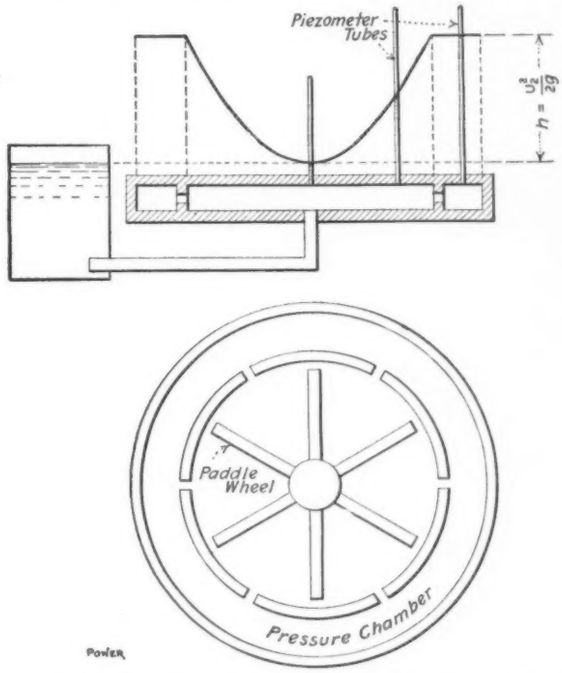


Fig. 4. Illustrating Pressure at Different Points

that amount in many cases. This may be accounted for in a number of ways. In any pump there is never a case of zero discharge; for a small amount of water, about 5 per cent. of the total rated discharge, will be short-circuited through the clearance spaces. This will tend

to make the shutoff head greater or less than $u^2_2/2g$, according to whether the pump has a rising or a falling characteristic. Also the more the vanes are directed backward the more tendency there is for internal eddies to be set up, which tend to reduce the head. This is one reason why different angles of vanes give different values of shutoff head, and another is that the more the vanes are directed backward the more rapidly will the pressure fall, with an increase of discharge, as will be shown later.

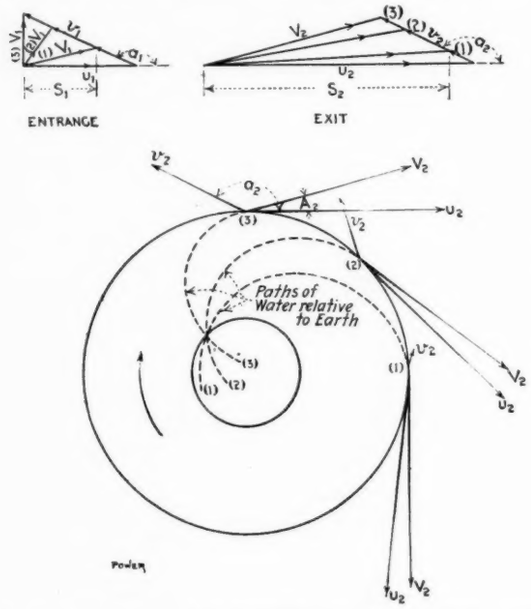


FIG. 5. RELATIVE VELOCITIES AT ENTRANCE AND EXIT

Furthermore, if the water in the eye of the impeller is not set in as rapid rotation as the impeller itself the head may be further reduced. There is also a tendency for the water surrounding the impeller to be set in rotation and this, on the other hand, tends to increase the head since the effective value of r_2 and thus u_2 is greater than the nominal value used. However, there is usually little deviation from the ideal case with most pumps and the actual head of impending delivery is such that h equals from 0.9 to 1.1 of $u^2_2/2g$.

HEAD DURING DELIVERY

When flow occurs the foregoing relation no longer holds, for other factors besides centrifugal force enter in. There may be an increase in head for small values of discharge, in which case the pump is said to possess a rising characteristic. On the other hand, the head may continually decrease as the discharge increases above zero, in which case the pump is said to have a falling characteristic. In the equations that will now be given the following notation will be employed:*

u = Velocity of point of impeller in feet per second;
v = Velocity of water relative to impeller in feet per second;
V = Velocity of water relative to earth in feet per second;
s = Tangential component of V in direction of rotation;
A = Angle between V and u;
a = Angle between v and u = vane angle;
A' = Angle made by diffusion vane with tangent;
F = Area of stationary passages in square feet at right angles to flow;
f = Area of impeller passages in square feet at right angles to flow;
H = Head delivered to water by impeller;
h = Head developed by pump;
h' = Head lost in pump by friction and shock;
q = Cubic feet per second;
w = Weight of a cubic foot of water = 62.5 lb.;
W = Pounds of water per second = $w\ q$.

The subscript $(_1)$ denotes entrance to the impeller, the subscript $(_2)$ exit from impeller, and subscript $(_3)$ a point in the casing. Briefly, v is called relative velocity and V is called absolute velocity. The following relations will also be noted:

$$H = h + h' \text{ and } s = V\ cos\ A = u + v\ cos\ a$$

Diagrams showing relations of these velocities at entrance and exit for several values of discharge are shown in Fig. 5. For a very small discharge the water takes path (1) for an intermediate discharge path (2), and for the normal discharge for which the pump is designed path (3).

Since the area of the impeller exit, f_2, is constant, the discharge is proportional to v_2 for

$$q = f_2\ v_2$$

Although the velocity V_2 decreases as v_2 increases, the area of the stream increases as the angle A_2 increases at such a rate that the product of V_2 and the corresponding area is an increasing quantity.

When there is no discharge the water in the eye of the wheel is in rotation; as the discharge increases experiment shows that this rotation decreases until at normal operation it is nearly zero. Thus there appears to be no sudden deflection of the water at entrance for any value of the discharge. The slight shock loss at entrance and the friction in flow through the impeller passages will be taken as proportional to the square of the velocity of flow, in accordance with the usual custom in hydraulics, and will be represented by $k\ v^2_2/2g$, where k is a coefficient determined by experiment.

With the turbine pump there will be a shock loss at discharge for all values of discharge except one, for with only one value of the discharge will the angle A_2 =

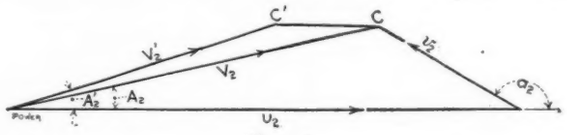


FIG. 6

A'_2. If the water leaves the impeller with velocity V_2 directed at angle A_2, it will be forced by the diffusion vanes to take the direction A'_2 and another velocity V'_2 (see Fig. 6). It will be assumed that the loss due to this sudden change is $(CC')^2/2g$. It can be shown that

$$(CC') = u_2 - k'\ v_2$$

where

$$k' = \frac{sin\ (a_2 - A'_2)}{sin\ A'_2}*$$

The total loss of head for the turbine pump may now be expressed as

$$h' = k\frac{v^2_2}{2g} + \frac{(u_2 - k'v_2)^2}{2g} \quad \text{(see curves Fig. 7)}$$

*See "Textbook on Hydraulics," by L. M. Hoskins.

With the volute pump water leaves the impeller with a velocity V_2 and enters a body of water in the casing, moving with a lower velocity V_3. In accordance with the usual method the loss due to the sudden reduction of velocity may be assumed as

$$(V_2 - V_3)^2 / 2g$$

For a very small discharge V_2 will be large, being nearly equal to u_2 and V_3 will be small. Thus the loss will be large. But as the discharge increases, V_2 will decrease while V_3 increases and thus the loss decreases. There will also be a slight change of direction, although not abrupt. The water in the case flows nearly parallel to a tangent to the impeller; the greater the discharge the greater the angle A_2 becomes, so that any loss due to a change of direction might here be included with the friction loss in the impeller passages. If V_2 be expressed in terms of u_2 and v_2, and V_3 in terms of v_2 and the ratio of areas of impeller passage and volute passage, the total loss of head for a volute pump will be

$$h' = k\frac{v^2_2}{2g} + \frac{\left(\sqrt{u^2_2 + 2\cos a_2 u_2 v_2 + v^2_2} - (f_2/F_3)\, v_2\right)^2}{2g}$$

Thus the losses approximately follow the same law in the two cases. In the turbine pump there is a gradual reduction of velocity but, except for one discharge, a sudden change in direction. With the volute pump there is no abrupt change in direction but a sudden change in velocity. The transformation of kinetic energy into pressure energy is incomplete in either case, but it is believed that it is more nearly complete in the turbine pump than in the volute pump. In spite of the extra hydraulic friction produced by the diffusion vanes it is to be expected that the efficiency of the turbine pump will be a trifle higher than that of a good volute pump. To secure a higher efficiency, other things being equal, we have merely to assume a slightly lower value of k.

The head input to the water from the impeller is given by either of the two following formulas: By the first method

$$\textit{Centrifugal head} = \frac{u^2_2 - u^2_1}{2g}$$

Then considering the conditions of flow through the impeller passage, by Bernoulli's theorem:

$$\frac{p_1}{w} + \frac{v^2_1}{2g} = \frac{p_2}{w} + \frac{v^2_2}{2g}$$

or the change in pressure due to change of relative velocity is

$$\frac{p_2 - p_1}{w} = \frac{v^2_1 - v^2_2}{2g}$$

Also the change of energy due to difference of kinetic energy of the water is

$$\frac{V^2_2 - V^2_1}{2g}$$

The total head delivered to the water by the impeller is the sum of these three items or

$$H = \frac{u^2_2 - u^2_1}{2g} + \frac{v^2_1 - v^2_2}{2g} + \frac{V^2_2 - V^2_1}{2g}$$

The second method is not so obvious nor so easily derived, but is more readily used. It is based upon the principle of angular momentum. (See Hoskins' "Hydraulics.") The resulting equation is

$$H = \frac{l}{g}(u_2 s_2 - u_1 s_1)$$

Either equation will give the same results.

With no discharge the water in the eye of the wheel will be in rotation so that the effective r_1 is zero and thus $u_1 = 0$. As the discharge increases this rotation decreases and when the discharge is that for which the pump was designed, then, ideally, there is no rotation in the eye of the wheel and the entrance velocity is radial, as shown in Fig. 5 (3). Thus for the normal delivery

$$s_1 = V_1 \cos 90 = 0$$

For these two cases the second term in the above expression becomes zero. For values of discharge between these two, the effective value of r_1 and thus u_1 is probably very small, due to the rotation of water in the eye of the wheel for small discharges and, although this rotation becomes less for greater discharges, s_1 approaches zero for larger discharges. It involves little error to omit the second term altogether; then

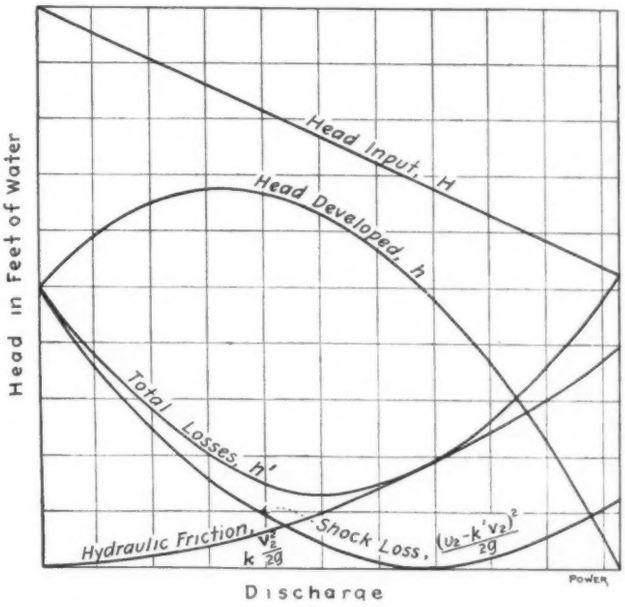


FIG. 7. VARIATION OF HEAD WITH DISCHARGE

$$H = \frac{l}{g}(u_2 s_2) = \frac{u_2}{g}(u_2 + v_2 \cos a_2)$$

In the case of no discharge it has been shown that $u_1 = 0$, and it is also seen that $V_2 = u_2$ and $V_1 = 0$. Thus by either of the preceding formulas

$$H = 2\frac{u^2_2}{2g}$$

But, as has been seen, the ideal head at no delivery is $\frac{u^2_2}{2g}$

However, referring to the expressions for loss of head in either the turbine or the volute pump we find that for $v_2 = 0$ that

$$h' = \frac{u^2_2}{2g}$$

The loss should be expected to approach this value, for, imagining a very small flow, the water will leave the impeller with a velocity nearly equal to u_2, while in the case it enters a body of water practically at rest, so that its kinetic energy is wholly lost. Thus for zero discharge

$$h = H - h' = 2\frac{u^2_2}{2g} - \frac{u^2_2}{2g} = \frac{u^2_2}{2g}$$

as was shown in the first place from a consideration of centrifugal force alone.

The ideal characteristic curves of a turbine pump are shown in Fig. 8. If a_2 is less than 90 deg., H increases as v_2 increases. If a_2 equals 90 deg., H is constant for all values of v_2. If a_2 is greater than 90 deg., H decreases as v_2 increases. The larger the angle a_2 is made the more rapidly will H decrease. The losses, h', subtracted from H give the net head developed, h. The hydraulic efficiency is equal to h/H. The gross efficiency equals the hydraulic efficiency times the mechanical efficiency, or it is usually the relation: water horsepower divided by brake horsepower.

Actual Head During Delivery

Actual tests show that this theory, while giving the general nature of the characteristics, does not give absolute values correctly. Thus a test would show that the actual head developed by the pump was less than is shown by Fig. 8. But it would also be found that the efficiency would not be correspondingly reduced. Since $H = h/e$, it is seen that actually H must be a curve of the general form shown in Fig. 9. Several reasons account for this discrepancy. The theory idealizes the conditions by assuming that all particles of water leave the wheel with a velocity, v_2, directed at angle a_2. Actually, the velocity of different particles will vary considerably from this average, and there is no assurance, moreover, that the average direction of all of them will be the same as the vane angle, a_2. Also, it has been assumed that the water flows through the entire impeller passage, but there is strong evidence to show that there is a "dead water" space on the rear of each vane. Some designers also maintain that, at normal discharge, the effective value of r_2 is not the value of the impeller radius but only the distance to the center of the impeller passage section taken normal to the vane at point of exit.

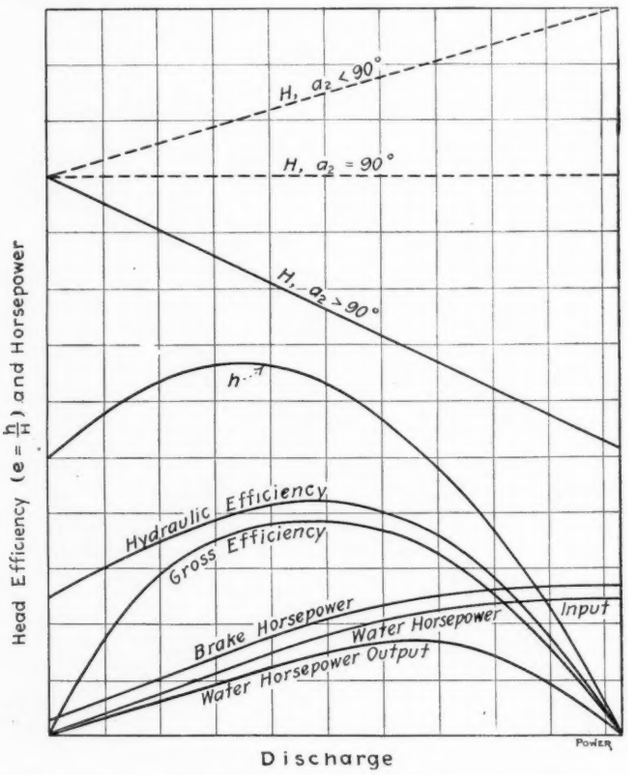


Fig. 8. Ideal Characteristics of Turbine Pump

The more vanes the impeller has, the more perfectly is the water guided and the more nearly do the actual characteristics approach the ideal. It is necessary to use sufficient vanes to guide the water fairly well, but it is undesirable to use too many because of excessive hydraulic friction. Within reasonable limits, however, the efficiency is but little affected. If the real H is lowered by fewer vanes, h is lowered at about the same rate, and the ratio is about the same.

By different values of a_2 and different numbers of vanes it is possible to produce a pump with steep, flat or rising characteristics. A steep characteristic is one where the pressure falls off rapidly as the discharge increases above zero. With a rising characteristic the pressure increases slightly for small values of discharge. A flat characteristic is intermediate between the two.

The value of the head developed by a pump when operating at its best efficiency depends quite largely upon the design of the pump. Very roughly, the most efficient head during delivery may be taken as,

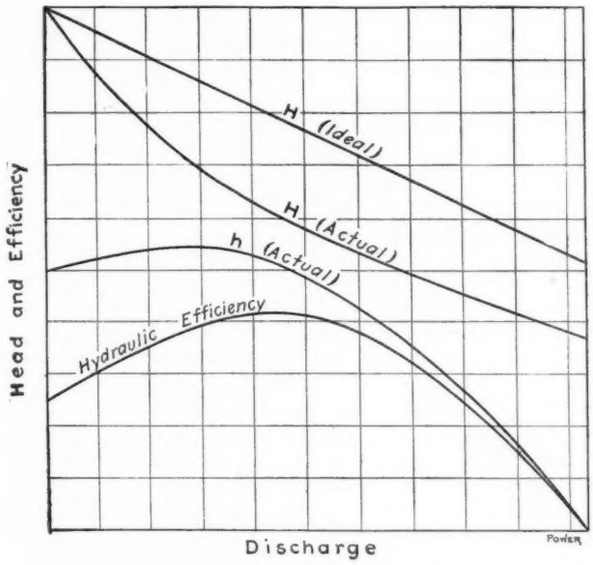


Fig. 9. Actual Head during Delivery

$$h = 0.6 \text{ to } 0.8\frac{u^2_2}{2g}$$

Thus the best lift of a given pump will vary as the square of the pump speed. Also the best value of the discharge, which is, of course, obtained with this best lift, will vary directly as the pump speed. Thus the horsepower will vary as the cube of the speed.

In Fig. 10 is shown a series of curves for different speeds. If it is desired to see what the discharge will be for different speeds at a constant head it is merely necessary to follow along a horizontal line for the given head. For a constant discharge follow the vertical line, and for maximum efficiency follow the curved line.

General Observations

The difference between water horsepower output and water horsepower input equals the hydraulic losses. As the speed is increased these losses will increase, but, as

the water horsepower increases at the same rate, it is probable that the maximum hydraulic efficiency will be nearly constant. The difference between water horsepower input and brake horsepower equals the drag of the impeller (disk friction) and the friction of the bearings. For very low speeds these losses do not increase as fast as the water horsepower with an increase in speed; hence the maximum gross efficiency will be greater as the speed and consequently the head increases. But when the higher speeds are reached the disk friction begins to increase faster than the water horsepower and the maximum gross efficiency begins to decline. Thus the head that may be efficiently developed by a single impeller is limited.

The speed and head are thus seen to exert some small influence upon the efficiency of a single pump. Assume,

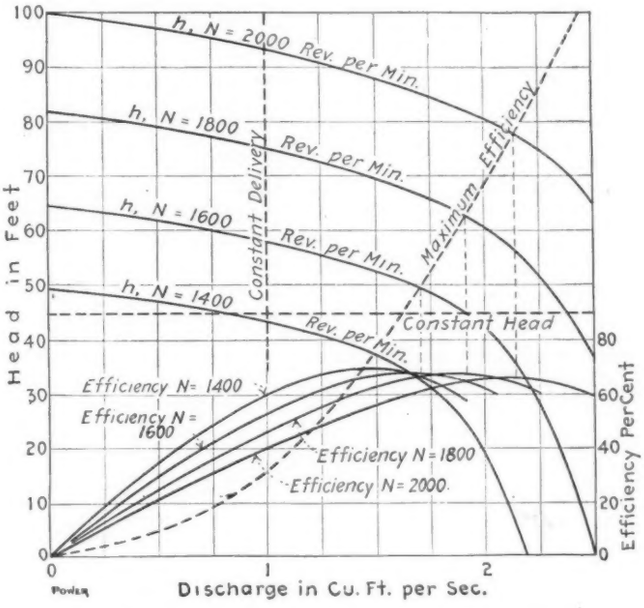


FIG. 10. DISCHARGE FOR DIFFERENT SPEEDS

however, a series of pumps of the same diameter of impeller and running at the same speed. They will all develop the same head, provided the vane angles are the same. But suppose that they are made with the impellers of different widths; the discharge areas will then be proportional to the widths and the quantity of discharge will vary in the same ratio. The friction of water in flowing through a large passage is less than that of a smaller quantity of water flowing with the same velocity in a

RELATION BETWEEN CAPACITY AND EFFICIENCY

Capacity, gallons per minute	Gross Efficiency, per cent.
75	55
200	65
900	70
5,000	75
10,000	80

smaller passage. Therefore, the hydraulic efficiency of the pump with a larger capacity would be somewhat greater than that of a smaller capacity. But the water horsepower of this series of pumps varies directly as the discharge while the disk friction and bearing friction would be practically constant for all. The result of these two causes is to make the efficiency largely a function of the capacity. A general idea of the relation between capacity and efficiency is shown by the accompanying table.

Test of a Two-Stage Turbine Pump

BY A. A. POTTER AND W. W. CARLSON

The following test may prove of value to those interested in pumping water for irrigation or other purposes by means of turbine pumps and oil engines.

The irrigation plant in question was located in western Kansas at an elevation of about 2850 ft. Water was found at a depth of 65 ft., but in order to eliminate some of the difficulties encountered, the pump was set at a depth of 123 ft., as shown in the sketch. Power was supplied by a 16x24, single-cylinder, four-stroke-cycle oil engine using 42-deg. Baumé oil. The pump was run at nearly 800 r.p.m. during the test, and the water was measured by means of a trapezoidal weir, all measurements being checked with a pitot tube.

The data of the test are given in the table and it is evident that for every gallon of fuel used, 5400 gal. of water was pumped. Figuring the cost of oil at 3c. per gal. gives 1800 gal. for 1c., and, as shown, 617.5 gal. of water was pumped per minute, at an expense of about ⅓c. An acre-foot would be pumped in 70½ min. at a cost of 24½c. At this rate about 10 acre-feet could be pumped in 12 hr. These figures are for fuel oil alone, and do not include any of the other charges.

TEST DATA AND RESULTS

Duration of test, minutes	60
Speed of engine, r.p.m.	184
Speed of pump, r.p.m.	798
Mean effective pressure of engine	60.0
Indicated horsepower of engine	67.6
Pump suction head, actual inches of mercury	6.46
Barometer	27.01
Pump suction head reduced to 30-in. barometer, feet	8.12
Pump discharge head, feet	127.06
Total head, feet	135.18
Head on weir, inches	4.1
Water pumped per minute, gallons	617.5
Fuel used per hour, pounds	46.5
Fuel used per minute, gallons	0.1141
Water pumped per gallon of fuel, gallons	5,400
Work done by pump per minute, foot pounds	695,000
Pump horsepower	21.10
*Engine horsepower	52.90
Mechanical efficiency of pump per cent	39.90
Heat value of fuel per pound, B.t.u., high	17,240
Heat value of fuel per pound, B.t.u., low	16,322
Heat value of fuel per gallon, B.t.u.	117,100
Duty of pump per 1,000,000 B.t.u., foot-pounds	51,900,000

* This is based on a mechanical efficiency of the engine of 85% and belt losses of 8%.

The duty of the pump was obtained by multiplying the foot-pounds of work done per minute by 1,000,000 and dividing the product by the B.t.u. in the fuel used per minute, or

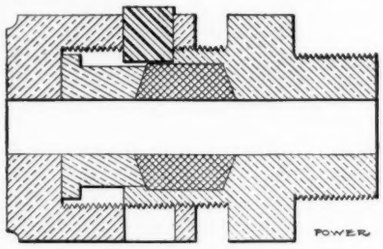
$$Duty = \frac{695{,}000 \times 1{,}000{,}000}{0.1141 \times 117{,}100} = 51{,}900{,}000 \ ft.\text{-}lb.$$

The Pacific Gas & Electric Co., Calif., has applied to the Railroad Commission for a certificate of public convenience and necessity for the construction of three additional power plants on the extension of Bear River, Placer County, and the construction of a transmission line from the Bear River development to Nicolaus, in the Sacramento Valley. The applicant stated that the construction would provide for 35,000 hp. at a cost of $2,396,000. A supplemental decision was rendered by the Commission on May 14 providing that the Northern California Power Co. should make returns to its patrons of all money previously collected in excess of the established rates.

In the movement for better efficiency, many men and firms are placing themselves before the public as specialists in efficiency, and those who wish to take up engineering work, are in doubt as to who may or may not be satisfactory. As an aid to those seeking work in efficiency organization, and those who desire to employ men for such work, the secretary's office of the Efficiency Society, 29 West Thirty-ninth St., New York, has become a clearing house where advice may be secured which will be impartial and authoritative.

Lawrence Improved Stuffing-Box

This stuffing-box is designed to slip on over the piston rod or valve stem and screw into place. It is then packed with any suitable packing. The gland is held against the



STUFFING-BOX

packing by a follower which screws up on the external threaded portion of the base. The gland of the stuffing-box, which is manufactured by the Lawrence Manufacturing Co., Key West, Fla., is thus forced against the packing without being turned.

A locking device, consisting of a lug which extends through an opening in the follower, fits in one of the grooves in the base. This locks the follower and prevents it from working loose. The locking lug is held in place by either a spring or screw.

❋

Haulage-Engine Repairs

BY T. D. PARFITT

Some time ago a serious accident occurred to a main haulage engine used on an endless-rope haulage system. One of the foundation bolts that held down the base plate under the pedestal of the main drum broke off close under the nut, permitting that end of the bearing to lift. At the same time one of the arms of the main drum cracked close to the rim.

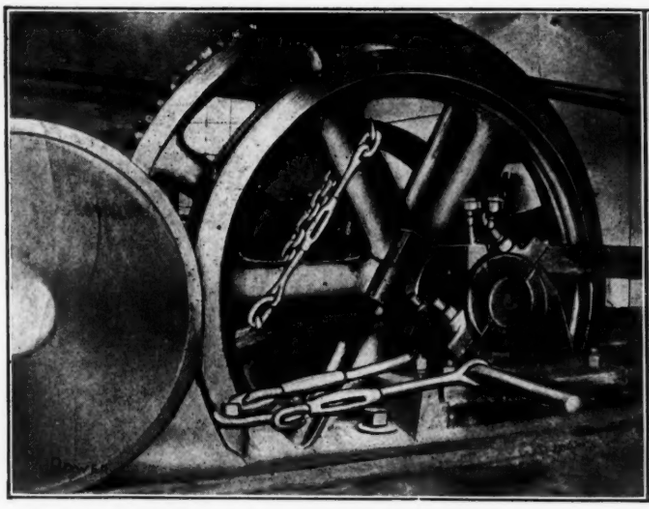


FIG. 1. TEMPORARY REPAIR

A strong chain and turnbuckle were rigged, as shown in Fig. 1, a small nick was cut in the arms of the drum to hold it in place and then the turnbuckle tightened. A hole was also drilled in the crack and tapped for a ⅞-in. bolt, which was screwed in place to prevent the crack from extending through the arm.

While one gang was working on this job, another worked in the foundation, cutting a round hole in the base plate, until nearly half of a nut hold was had on the foundation bolt, then a clamp was placed over the engine-foundation bolt, to which two turnbuckles were attached. The other end of each eye-bolt was made with a large eye on one end through which a 2-in. rod was run and placed behind the bolts, holding the pedestal to the base plate. This will finish the day's work without loss of tonnage.

We then went to work and drilled two 2-in. holes in the concrete foundation about 3 ft. deep. A bolt made with grooves cut around it was inserted in each hole, which were then filled in with babbitt metal. Then two clamps were made and placed, as shown in Fig. 2, reaching from the base of the engine to the base plate of the drum pedestal. They were then drawn tight. The engine has been in constant use for nearly a year since the repair and has not given any trouble, and at present it looks as though it would run indefinitely.

❋

New Method of Boiler Cleaning

A new method of boiler-scale removal has been recently invented and placed upon the market in England by Adolph Schror, says *Coal Age*. This method is radically different from those common in this country, which are strictly mechanical in their action.

The principle of the new apparatus is simple. It consists in the employment of an oxyacetylene flame of high temperature, but of moderate pressure, which is rapidly played upon the scale. The effect is to disintegrate and break down the deposits, and, notwithstanding the high temperature of the flame, the makers claim that there is no cause for anxiety on the score of undue heating of the boiler tubes, and that the apparatus may be used to remove the thinnest scale.

Contracts under this system are undertaken on the "no cure, no pay" principle, by the Pyro Boiler Cleaning Co., of London, and it is understood that thus far the results obtained have been entirely satisfactory.

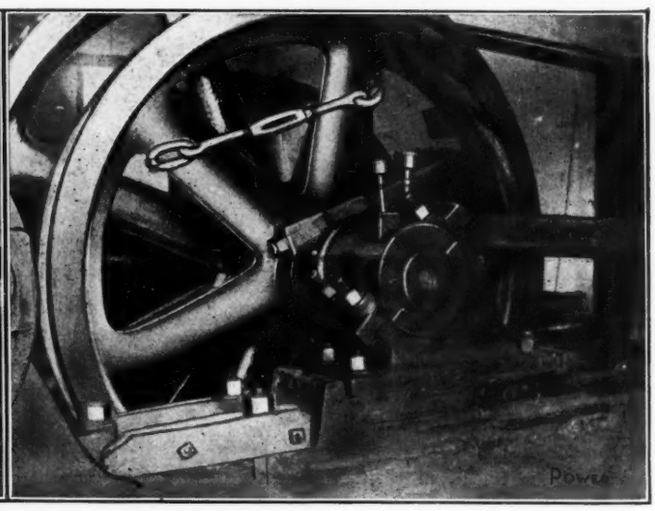


FIG. 2. PERMANENT REPAIR

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Half a million dollars is to be spent for a power plant project to supply electric light and power to Las Vegas, Nev., and adjoining valleys. The water for developing the power is to come from the Charlestown mountain range above Indian Springs, its source being 11 small springs.

Development in V-Notch Recording Meter

By Joseph Esherick

SYNOPSIS—The advantages of this form of V-notch type of meter are brought out, which consists of the long storage chamber, new type of clock-driven integrator, and simple method for testing when the meter is in operation.

There are various methods for measuring water and other liquids, such as by the pitot tube, venturi meter and the V-notch weir, all of which have found favor with the users. The advantages claimed for the latter method are increased accuracy at high and low rates of flow, depending as it does upon the law of gravity, water falling over a 90-deg. V-notch, the amount of which is a known quantity (Thompson's formula). Further, its accuracy is unaffected by temperature or velocity changes, and the flow may be checked at any time.

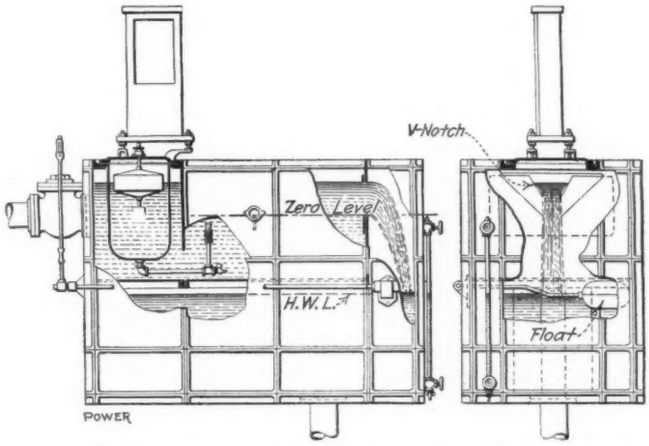


Fig. 1. Extra Storage Type of Meter

Increased Storage Space above and below Weir Chamber

The V-notch weir type of meter is independent of temperature and velocity changes, because the design permits of a storage space where water or liquid being measured can accumulate before passing over the weir. Although the flow into the tank of the recorder may fluctuate, its irregularities are absorbed by this stored volume, resulting in a perfectly steady flow over the weir.

In the accompanying drawing, Fig. 1 illustrates a new patented extra storage type V-notch recording meter. The advantage of this type of tank is found in the long still-water chamber above the weir, and an even longer storage chamber below the weir. It is found in practice that the longer these surfaces can be made, the steadier the chart record, and hence the more accurately will the meter record fluctuating rates of flow.

The lower storage surface below the weir controls the opening and closing of the inlet valve, and the advantage of increased storage at this point is, that the larger this surface, the smaller will be the vertical change for a given change of volume flowing over the weir, affording a smoother chart and one more easily planimetered.

Tests of this type of meter operating the inlet valve from the short water surface below the weir, and then with the same load conditions lowering the surface until it extends the length of the tank, as shown, result in widely different curves. The curve recorded when the control valve is operating on the long storage surface is very much smoother than when the valve is operating on the short storage surface.

Another advantage of this new design is found in the ease with which the shape of the tank lends itself to peculiar installations. Some cases require a very much larger storage space than others. In these cases it is easy to increase the depth of this storage space, by making the tank deeper the desired amount, at the same time keeping the same length of tank. This design seems to give maximum storage space for minimum floor space.

For plants where the head room is limited there is a low-head type of recorder, Fig. 2. The tank is longer than in the new type, but the distance from the zero line to the storage-water level below the weir is less.

New Type Clock-Driven Integrator

In the past the V-notch type of recorder has been equipped with a clock mechanism for driving the recorder chart, and a constant-speed motor for driving an integrator. Under extreme conditions where the instrument was subjected to severe heat, the clock mechanism has maintained perfect accuracy, but the motor has not proved quite so satisfactory. The heat sometimes so affects the lubrication of the motor that frequent oiling is required.

Although this was not so much a mechanical difficulty as lack of attention from the operator, it has, nevertheless, seemed wise to avoid it.

Guided evidently by the success of the clock mechanism driving the chart drum, the manufacturer has developed

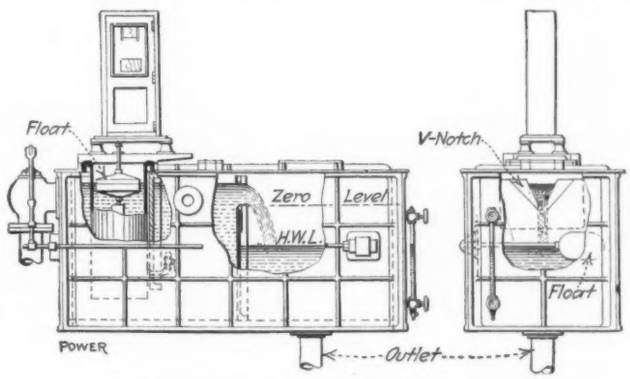


Fig. 2. Low-Head Type of Meter

the clock-driven type of integrator shown in Fig. 3. It consists of a clock-driven aluminum disk which revolves about four times an hour. Across the radius of this disk a friction wheel moves, which is attached to and drives a counter mechanism, and as this wheel moves farther and farther from the center of the aluminum plate the counter adds up more and more. The counter itself is supported on a frame attached to the horizontal slider bar, which in turn is moved laterally by the pointer arm, which engages the cam surface. The pen arm is also attached to this same slider arm. This arrangement makes it possible for the operator to obtain a reading on

either the counter dials or on the chart, because each system is driven by separate clock mechanism.

Method for Testing While in Operation

A disadvantage to all types of recorders and meters has been the impossibility of testing them without trouble and expense. The most positive method has been the erection of an elaborate outfit of tanks on scales for testing by weight.

In Fig. 4 is illustrated what is known as the "hook gage" by which the V-notch type of meter seems to lend itself to a test of great simplicity, as it can be tested at the normal rate of flow, whether fluctuating or not, and at the highest rate, corresponding with the peak load of the plant.

The "hook gage" is illustrated at the right of the tank. It consists of a glass water gage containing a hooked vertical rod inside. It has been attached to the V-notch tank in the middle weir section, and the hook is set on the water line, which is the height of the water falling over the V-notch.

The hook is adjustable up and down, and has a scale with a vernier attached, so that the height can be read to hundredths of an inch.

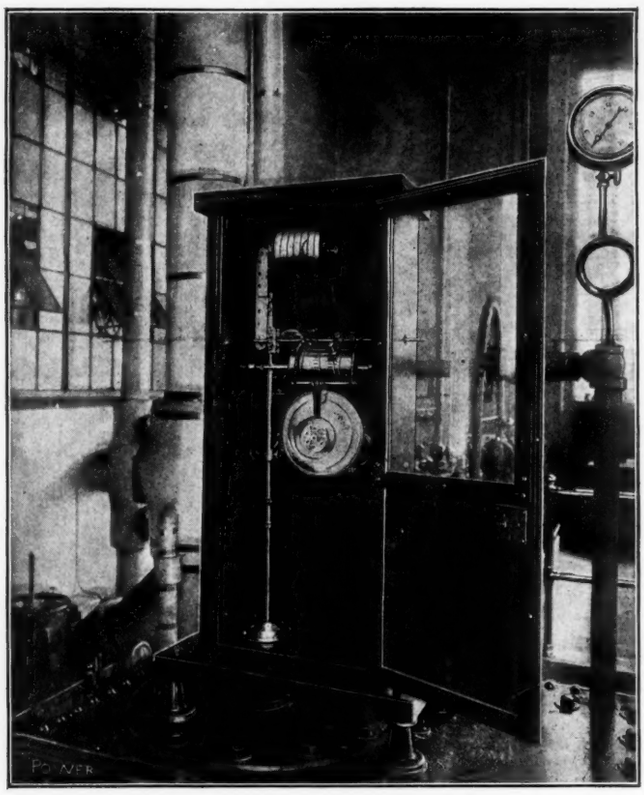


Fig. 3. Clock-Driven Type of Integrator

In testing a V-notch meter this hook gage is used in taking readings every three minutes for two or three hours, and these values of the head of water flowing over the V-notch are substituted in Thompson's formula for the flow, and a value obtained of the quantity which has passed over the V-notch in this time. This quantity is now compared with the quantity which the recorder shows by planimetering the chart in the same time.

For users who prefer not to purchase a gage for testing purposes, the manufacturer furnishes one at a nominal rental.

Accurate measurement of water and other liquids is a subject rapidly growing in importance, and remarkable advance has been accomplished in the last few years.

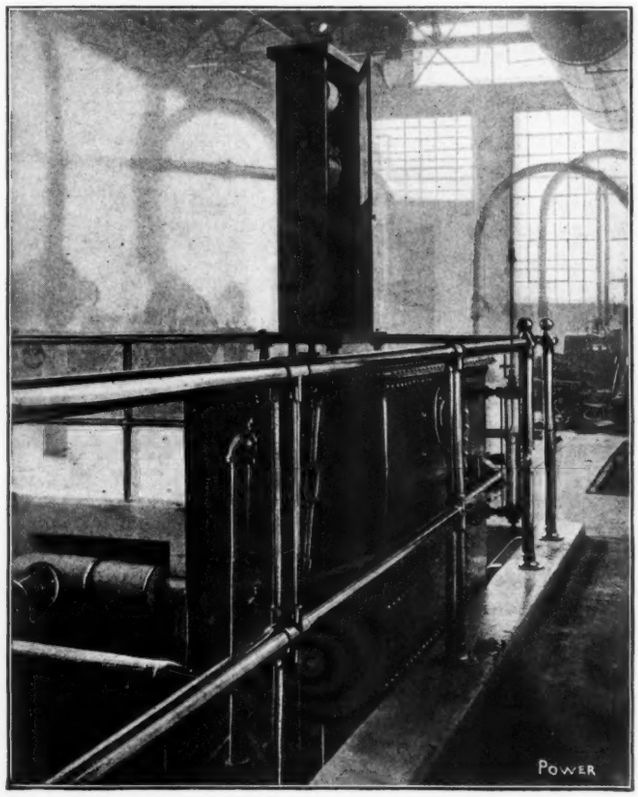


Fig. 4. Meter and Hook Gage

Probably the largest application of water-metering appliances has been in steam plants for the measuring of boiler feed, although its possibilities are almost unlimited, and hundreds are in use for a wide variety of other purposes.

Chimney Damaged by Lightning

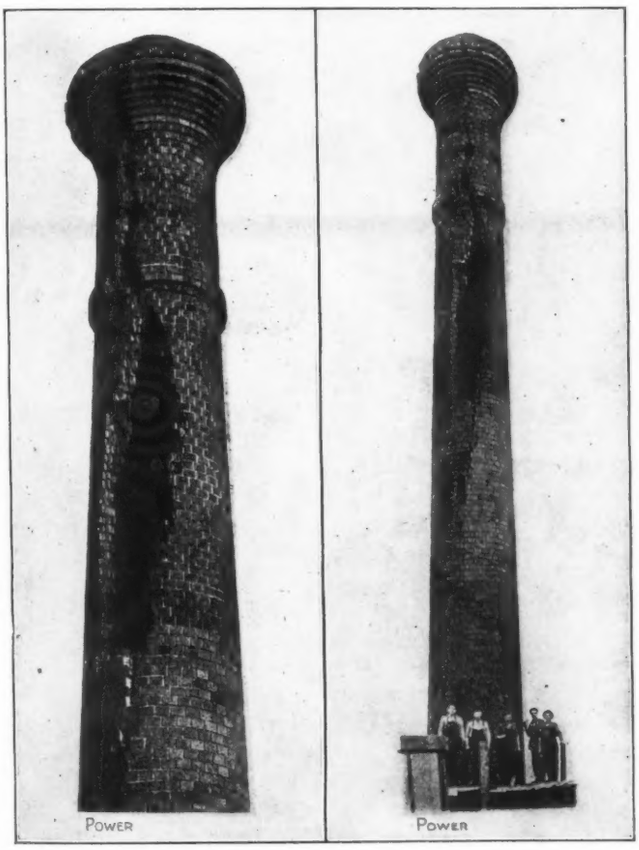
By A. D. Williams

The 5x135-ft. beautiful tapestry-brick chimney serving the heating plant of the two factory buildings of M. T. Silver & Co., and the Sunshine Cloak & Suit Co., Cleveland, Ohio, was struck by lightning during a heavy thunder storm that passed over the city on the night of June 19. The storm came from the northwest and the lightning struck the north side of the chimney just below the brick astragal, cutting a gash about 3 ft. wide at the widest point and opening a crack in the shaft that extends from the second course of brick in the astragal down to a point just below where the men are standing, a distance of about 60 ft. The major portion of the wreckage fell through the roof of the Silver & Co. factory within a few feet of the stack, but some pieces of brickwork were thrown from 20 to 30 ft., breaking skylights, while a small part was thrown out into the street in front of the building, a distance of about 70 ft. A loose piece of brickwork hangs in the gash just above the small hole in the shaft. A scaffold was erected around the chimney

so that the upper 60 ft. can be torn down. The damage is estimated at $5000.

One of the interesting features of this wreck is that the radial brick of which the chimney is built were cut through and the mortar seams were not followed. In some places brick were cut within an inch of the end and still adhered tightly to the mortar. The mortar dowel was shown at nearly every horizontal seam. Pieces comprising parts of several brick with the mortar between them held together after their tumble. The chimney was built by the Alphons Custodis Chimney Construction Co.

[This accident serves to show what a radial, tongue-and grooved-brick chimney will withstand without crumbling. Had the chimney been of ordinary solid brick it would undoubtedly have fallen when it was hit.—EDITOR.]



HOW LIGHTNING GASHED THE CHIMNEY

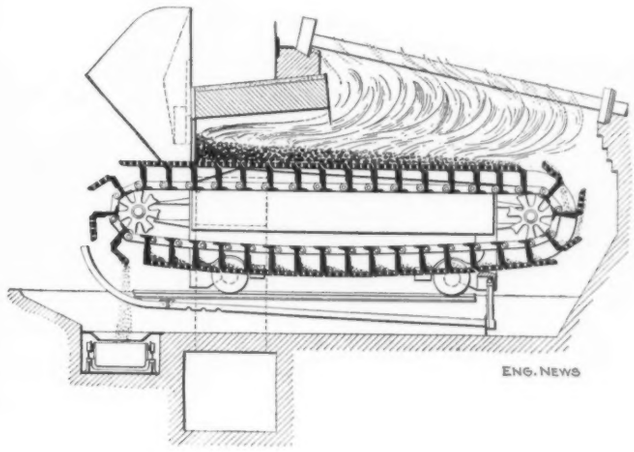
It is estimated that investment in the central-station industry is capitalized today at about $2,500,000,000, and that the earnings are apparently around $350,000,000. Quoting from the report of the Committee on Progress before the 1912 convention of the National Electric Light Association, "There can be no great exactness to these estimates, as the general census of the central stations will not be taken until next year, and the last United States report is that of 1907." It is apparently estimated by those who ought to know that the central station income is somewhere around $400,000,000. The "Electrical World" gave the following data on the electrical industry:

Value of electrical apparatus made	$350,000,000
Electric railway earnings	635,000,000
Central-station earnings	450,000,000
Telephone earnings	350,000,000
Telegraph earnings	85,000,000
Isolated-plant service	125,000,000
Miscellaneous electric service	125,000,000

Making a grand total of approximately $2,120,000,000.

Chain-Grate Stoker Which Returns Its Ashes

At the new power station of the combined municipal system of Burslem, Fenton, Hanley, Longton, Stoke and Tunstall, in the Staffordshire pottery area of England, water-tube boilers have been equipped with a chain grate of new type, recently developed. This is shown in sectional elevation in the accompanying figure from London *Electrician,* Apr. 11, 1913. The device consists essentially of an endless chain of L-shape grate bars mounted (inverted) on chains, the links of which run over sprocket wheels driven from a countershaft. The tops of the grate bars are perforated and slotted for the passage of air through the fuel. This air supply enters from two rectangular conduits, one at each side of the stoker near the front end, opening into side-wall recesses of graduated height. This allows automatic variation of the quantity of air to the different parts of the fire; the back receiving the smallest quantity where the fire is thinnest. Conduits also supply air to the front and back of the furnace through suitable control dampers. For the three boilers in this plant (each with a steaming capacity of 18,900 lb. per hr.) two fans are employed, each delivering 118 cu.ft. of air per minute.



A CHAIN-GRATE STOKER AND ASH CONVEYOR

As shown in the accompanying figure, the shape of the bars is such that when the chain passes over the rear sprocket the ashes left on top of one bar drop to the inside angle of the next forward bar, to be carried along and dumped out of that place when the bars are again separated at the front sprocket. In this way continuous removal of ashes is secured. These grates were made by the Underfeed Stoker Co., Coventry House, South Place, London, E. C., England.

A large hoist has been erected in the shop of the Nordberg Manufacturing Co. and will soon be shipped to the Inverness Ry. & Coal Co., of Inverness, Cape Breton Island. This hoist, which is claimed to be the largest of its kind in the world, has two 34x34x72-in. cylinders and two 10-ft. drums, clutched to the shaft. Each drum, according to the "Engineering and Mining Journal," is capable of handling 10,000 ft. of 1½-in. rope. The load consists of 12 cars weighing altogether 40,680 lb. loaded. The rope weighs 35,500 lb. The hoist will be used in an inclined shaft dipping 16 deg. at the surface and 35 deg. at the bottom. The present depth is about 6000 ft. The starting stress on the rope will probably be about 41,000 lb.

ELECTRICAL DEPARTMENT

Installation and Care of Storage Batteries—I

By H. M. Nichols

Nearly every electric-generating plant, from the modest installation used for lighting summer residences to the large central stations, has its equipment of storage batteries. Sometimes the batteries are intended to help carry the peak load; sometimes their function is to furnish power during certain periods of the day when the demand for current is light; or they may be the chief dependence for current as in the case of private lighting plants, where the dynamo is run a few hours each day to charge the battery, which is then called upon to furnish all the current used during the evening. But no matter under which one of these heads the battery falls, it is frequently placed in some dark inaccessible and ill-ventilated corner, and the care it receives is of the most perfunctory kind.

It is not surprising under these conditions that the battery soon begins to give trouble, and plays out in a few years, entailing a heavy expense for the replacement of plates, etc. On the other hand, if the battery is properly installed and is given the proper care the depreciation can be rendered very small.

The present discussion will first consider the layout and installation of storage batteries, then the operation and maintenance will be taken up.

The battery room should always be separated from the rest of the plant as the acid fumes are very destructive to the generating machinery, their action on the insulation of generators and wiring being particularly destructive. The fumes also corrode the switchboard connections, cable sheaths and any other exposed parts. Moreover, the fumes if breathed are poisonous and are likely to cause a very disagreeable cough. The battery room should be located as near the main switchboard as possible, thereby reducing the cost of the connecting conductors.

The walls and floor of the room should preferably be of brick or tile. If wood is used it must be protected with several coats of acid-resisting paint. Also protect all exposed metalwork in a similar manner. The floor should pitch toward a central point, having a drain connected with the sewer through a lead trap.

The room should be well lighted and ventilated and the window panes must be either ground glass or painted glass in order to keep the direct rays of the sun from striking the battery. If the sun's rays fall directly on the battery, it will cause loss of charge by local action, and also cause the electrolyte to evaporate quickly.

In the case of large installations where lead-lined tanks are used in place of glass jars, the sun's rays are not so objectionable, provided they are not directed into the top of the tanks.

In large installations exhaust fans are often provided for carrying off the acid fumes. The battery room should be so designed that the battery will not be exposed to either extreme heat or cold, and consequently it will be necessary to provide some means for heating in cold weather.

In small installations where it is not possible to have a separate room for the battery it should be housed on shelves placed against one of the walls of the generating room. These shelves should be entirely encased with close-fitting matched boards so as to form an air-tight closet. The front should be provided with large tight-fitting doors, which when opened expose the entire battery. The acid fumes are carried off to the outside through a wooden or fiber conduit. The entire inner surface of the battery closet and all exposed ironwork should be given several coats of asphaltum or other acid-proof paint. In cold localities the ventilating duct must be provided with a wooden damper which can be kept closed in cold weather except when the battery is being charged.

Setting Up and Connecting the Cells

The cells are sometimes supported by shelving along the walls, or more often by benches that rest on the floor. The shelving and benches should be shellacked and then coated with paraffin to protect them from the unavoidable acid drip and spray. Or they may be covered with asphaltum or other acid-resisting paint. In the case of large installations the tanks are sometimes set directly on the floor. In any instance the cells must be easily accessible for inspection and the replacement of plates. There should be sufficient headroom to take out the plates without removing the cells.

Care must be taken to insulate the cells from the ground as a frequent cause of trouble is due to leakage of the current over the surface of the cells and the supports to the ground. The acid fumes keep the surfaces of the cells and supports sufficiently moist to render them good conductors. Because of this danger from current leakage it is necessary to set the cells on glass or porcelain insulators. The best plan is to stand each individual cell on four insulators of the common petticoat type, since the method will prevent current leakage between the individual cells as well as between the cells and the ground.

Sometimes a double system of insulators is used. In small installations, however, where it is not desired to go to the expense of supporting each cell separately the benches on which the cells set can be insulated from the ground instead. Lead-lined tanks are usually set directly on the insulators but sometimes glass cells are set on wooden trays that rest on the insulators. The trays are filled with sand to equalize the strain and absorb the acid drip.

The cells are usually connected in series and great care must be taken to join the positive terminal of one to the negative terminal of the next, and so on. If a mistake is made in connecting a cell it will be ruined when the charging current is turned on. The best indi-

cation of the polarity of the plates is their color. The positive plates are a light brown when discharged and a chocolate color when charged, while the negative plates vary from a light to a dark gray.

Before placing the plates in the cells, carefully examine and remove any foreign substances that may have lodged between them. See that the hard-rubber insulators are properly spaced and that the positive plates do not come in contact with the negative ones. Also inspect the jars for cracks that might allow the electrolyte to leak out. The cells should be perfectly clean and the plates should clear the bottom from one to six inches, depending upon the capacity.

If the cells are filled with electrolyte before they are permanently connected together, it is a good plan to test the polarity of each cell with a low-reading voltmeter before making the permanent connections. Or the polarity can be determined by dipping wires leading from the two terminals in dilute sulphuric acid, the one from which the most bubbles of gas arise being the negative.

In small cells the connections are made by clamping or bolting the projecting lugs together. The connections should be scraped bright and clean and the bolts set up as tightly as possible. Then paint with asphaltum to prevent corrosion, and cover with okonite tape. A better method is to weld or "burn" the lugs together. If the terminals are to be burned together they should first be scraped free from dirt and oxide. A convenient scraper can be made by fastening a triangular piece of sheet steel to a suitable wooden handle. For soldering flux, use ordinary tallow. Never use acid or soldering salts, as joints made with these fluxes are likely to corrode in the course of time.

The method of welding the lugs together will, of course, depend somewhat on their size and shape. A convenient method on moderate-sized cells is to butt the two connecting lugs that are to be welded together. These lugs should be chamfered off on their top edge so as to leave a V-shaped channel where they butt together. A sheet-iron trough is then bent up having a cross-section the same as that of the terminals. This trough is then slipped over the lugs from the bottom side, is held in place with a clamp and serves to keep the molten lead in place while the lugs are being burned together.

Hydrogen gas gives the best results, but if it is not obtainable, ordinary illuminating gas may be used. If hydrogen gas is used, make sure that all of the air has been expelled from the generator before attempting to light it, since if there is any air present there is danger of an explosion. The hydrogen gas is tested for the presence of air by filling a test tube with water and inverting it in a dish of water. The test tube is then filled with gas by means of a rubber tube which is connected to the hydrogen generator, the free end being pushed up into the mouth of the test tube. As the gas fills the tube it will force out the water. When the test tube has been completely filled, remove it from the basin, keeping it inverted all the time, as hydrogen is much lighter than air, and test with a lighted match. If the gas is free from air and safe to use it will burn with a steady, almost colorless flame. If there is air present, however, the gas will explode with a sharp noise when the match is applied.

The solder should be pure lead, as tin is attacked by the acid fumes. It should be melted off the sticks and allowed to flow into the V-shaped trough between the ends of the terminals. At the same time the ends of the lugs should be kept near the melting point. Great care must be taken not to entirely melt the ends of the lugs.

Another method of connecting the terminals is to wrap a strip of lead around the terminals and put a sheet-iron mold or trough outside of this and then pour in melted lead. The lead strips must be scraped clean to insure a good joint.

The wiring for the battery room should be, preferably, lead-covered cable. If this is not used there is danger of corrosion, and liability of some of this corroded copper falling into the cells, which would be very injurious.

Care should be taken not to have any iron hooks, braces or other pieces of metal project over the cells, as there is great danger of contamination by the falling of corroded material into the cells.

For convenience in inspecting the cells a small portable incandescent lamp may be provided. Special lamps are obtainable for this purpose which are flat so that they may be inserted into the electrolyte between the plates and the jar. This lamp should have sufficient rubber-insulated flexible cord to reach to all parts of the battery room.

The battery switchboard, which must be located outside the battery room usually forms a panel of the main switchboard. It should be equipped with a voltmeter, ammeter and device for regulating the charging voltage. In installations where it is not convenient to regulate the charging voltage by varying the dynamo voltage, resistance boxes are used for that purpose. Or in large installations a motor-generator set may be used, this being the most efficient form of regulation.

It is also essential to provide both overload and reverse-current circuit-breakers. In case of a heavy overload or short-circuit the battery would be injured if there were no protecting devices present. In small installations inclosed fuses may be substituted for the overload circuit-breaker. The function of the reverse-current circuit-breaker is to prevent the battery current from flowing back over the charging circuit in case the generator voltage should fall below that of the battery during the charging period.

Electrolyte

Concentrated sulphuric acid (oil of vitriol) is much too strong for use in storage batteries and it is, therefore, necessary to dilute it with water in the ratio of about five parts of water to one part of acid.

Commercial sulphuric acid will not do for battery work as it contains many impurities, such as iron, arsenic, copper, chlorine, etc. Use only chemically pure acid (symbol C.P.). The water used must be distilled as ordinary river or well water contains injurious impurities. Both water and acid should be kept in tightly-stoppered glass carboys, to prevent the introduction of impurities. If the distilled water is stored in barrels there is danger of its absorbing organic material from the barrels. Mix the electrolyte in a large earthenware or glass receptacle. Pour the acid very slowly into the water as there is considerable heat generated. *Never pour water into the strong acid*, as there is great danger of the operator being burned with the acid which will fly in all directions. *Always pour the acid into the water.*

The proper specific gravity of the electrolyte will de-

pend somewhat on the type of battery and the purpose for which it is to be used. In ordinary stationary installations a specific gravity of 1.200 is used while in automobile and portable batteries the specific gravity goes as high as 1.300. The advantage of a high specific gravity is low resistance, but there is great danger of the plates being injured by sulphating if the gravity is run too high.

The mixture should be allowed to cool to 60 deg., and then be brought to the proper specific gravity by the addition of a small quantity of acid or water as the case may require. Always see that the electrolyte is cool (60 degrees F.) before pouring into the cells, it being a good plan to carefully prepare the mixture twenty-four hours before it is wanted.

Tests for Impurities in Electrolyte

It is very important that the acid for making the electrolyte be chemically pure and it is recommended that each carboy of acid be tested for impurities. It is also a good plan to test the electrolyte in the cells once a month, as it may have been contaminated by the corrosion of iron fittings near the cells.

Copper salts also find their way into the cells in a similar manner. Nitric acid and chlorine may be present in the new plates in small quantities.

In case any impurities are found in the electrolyte it should be drawn off, the cells and plates washed out with pure water and fresh electrolyte added.

Test for Hydrochloric Acid (*Chlorine*)—To a small quantity of the diluted electrolyte add a few drops of nitric acid (HNO_3) and then add two or three drops of silver nitrate ($AgNO_3$). The formation of a white cloudy precipitate indicates the presence of chlorine in some form.

Test for Nitric Acid—A very sensitive test for nitric acid, is to mix a solution of diphenylamine ($NH(C_6H_5)_2$) in concentrated sulphuric acid (H_2SO_4) and add it to the sample under test, the presence of nitric acid will be indicated by a blue color.

Test for Iron—Fill a test tube with the diluted electrolyte and heat it to the boiling point, add several drops of concentrated nitric acid (HNO_3) and boil again. Repeat this operation two or three times. When the solution is cold add a few drops of potassium-sulphocyanide (KCNS) which will color the solution a deep red if there is any iron present.

Test for Copper—To a diluted solution of the electrolyte add ammonium hydrate (NH_4OH or common ammonia) until the resultant mixture gives an alkaline reaction. A deep-blue color indicates the presence of copper.

Test for Arsenic—To a diluted solution of the electrolyte add an equal portion of hydrogen-sulphide solution (H_2S). A yellow precipitate indicates the presence of arsenic.

If the electrolyte has been previously used in batteries there is likely to be a black precipitate, due to the presence of lead, and often the commercial acid contains a little lead which does no harm. In making the foregoing tests, it should be kept in mind that the reagents used must necessarily be pure or the results obtained will be unreliable. Use only those reagents that are labeled chemically pure.

Transformer Frequencies

Any transformer designed for a given output and frequency can be operated on a higher frequency with a slight increase in efficiency. On a lower frequency the efficiency is decreased and, therefore, the output for a given size. Transformers of modern design usually have sufficient capacity to be operated on half frequency at full-load rating without overheating. This is effected to a large extent by the location. If the transformer is located where the surrounding temperature is high and has poor ventilation it might reach a dangerous temperature, or if the surrounding temperature is normal and the ventilation is good the transformer may operate satisfactorily so far as being affected by excessive heating.

If the frequency is reduced from 60 to 25 cycles a safe practice would be to work the transformer at about 90 per cent. full-load rating for ⅓ kw.; sizes from 4 kw. up, about 95 per cent. of their full-load rating. A better method would be to run a heat test for about 8 or 10 hr. at the reduced load, the rise in temperature of the coils should not exceed 104 deg. F. by thermometer, or 122 deg. F. by resistance rise.

A transformer working continuously under the above conditions will soon use enough power to pay for new apparatus, due to the lower efficiency.

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Static Charges on Belts

In the June 10 issue, Mr. Chase states in a letter that he has had much to do with belts in the past 16 years but has never known a case where static electricity could not be cured by treating with "Cling-Surface." It is very evident from this statement that his experience with different conditions has been limited; for I have seen several cases of static electricity that Cling-Surface would not touch.

When the static charge is caused by slipping of the belt, then, oil, Cling-Surface, or anything else that will remove the cause, will also remove the effect. Under other conditions, however, it is of no benefit, whatever. For instance, I ran a high-speed engine and generator having two belts, one running on top of the other, which necessitated a certain amount of slippage; this and the belts flapping together running at a very high speed caused them to carry a heavy static charge that Cling-Surface would not cure but made all the worse.

In another case, I ran a high-speed engine belted to a shaft that passed very close to the boiler safety valve, when the boilers were blowing, the belt would become heavily charged and the only cure for this case was to ground it or to stop the boilers from blowing.

Stockett, Mont. R. S. Hart.

❋

The following communication was received by a La Crosse (Wis.) electrical firm from a farm customer. The son of the soil, it seems, had ordered a lamp fitting while under an impression somewhat similar to that of the Kansas farmer who bought a motor to do his farm work, although there wasn't a power wire within 25 miles. The Wisconsin agriculturist "came back" as follows: "Dear Sir this letter is to acknolage to you of the recept of your two ball adjusters but in addition I will make you understand that I misunderstand you I thought that it was a lamp by itselph and not a aparatus which is of no use to me as I have no curent of electrice so you see. I want to send them back to you again and you send my money back to and nothing more to say your trully." —"Electrical World."

GAS POWER DEPARTMENT

Lignite Suction-Producer Troubles

By George W. Muench

The operation of a producer is difficult compared with the operation of a steam plant, because a producer does not allow the operator to watch his fire, and, therefore, he does not know what is going on inside, except through the action of the engine and the appearance of the gas flame at the try-cock. The anthracite producer is the simplest to handle. The lignite producer requires more skillful handling because of the poor grade of fuel, large amount of ash, and the auxiliary apparatus which separates the tar from the gas.

The following troubles and their remedies have come within the experience of the writer and may help operators who are having their troubles and who may not have had the opportunity to study the producer in detail.

Lignite being an extremely low-grade fuel is high in volatile matter, and usually high in ash. These two items must be kept in mind continuously when operating a lignite producer. The ash may be as low as 3 or 4 per cent. or it may be as high as 50 per cent. Western lignites especially adapted to producer use average about 12 to 18 per cent. ash. However, lignites with ash as high as 40 per cent. have been used successfully. Being high in ash this fuel must be worked frequently while the plant is in operation to prevent the ash bed from getting too deep.

It is practically impossible to tell an operator how often his producer must be worked, as it depends on the load, the kind of fuel and the type of producer. Again, some plants operate 24 hr. per day every day in the month, while others operate only 8 to 10 hr. and give plenty of opportunity on Sundays for general overhauling and repairing. It is, of course, the continuously operated plant that requires the most skillful and careful handling. The lignite suction producer operating 24 hr. continuously for some weeks or months, using lignite that does not clinker badly, need not be worked oftener than once every 5 to 8 hr., depending on the variation in the load. Where possible, it is well to work the producer during those periods when the load is a minimum. Working the producer with full load must be done carefully, as too much air will weaken the gas so much that the engine will slow down. It often helps to slightly advance the spark on the engine while working the producer, as the advanced spark will take care of the weakened gas. This, of course, applies to cases where by "working the fire" is meant slicing across the grates with bars through the poke holes. Where a producer is equipped with shaking grates it may not be necessary to work the fire otherwise than merely shaking the grates, and, therefore, no air will enter to weaken the gas.

Handling of the ash can ordinarily be accomplished without much trouble, yet the writer knows of cases where the air entering through the ash door while removing the ashes would weaken the gas enough to cause the engine to slow down. If such is the case the ashes must be removed as rapidly as possible and a small amount at a time. When operating only part of the day ashes had best be removed after shutting down in the evening.

The common trouble with many lignites and the trouble that causes the hardest labor, unless prevented in time, is clinkering. Lignites vary greatly as to their clinkering qualities, even though their proximate analyses be practically the same. Some require very little steam while others require considerable to keep the clinkers soft. It is of the most vital importance to give a producer the necessary amount of steam, yet it is of just as great importance to prevent an excess of steam. An excess will cause too low a fire temperature, and also often too much hydrogen in the gas, which will cause premature ignition in the engine. In case of decidedly varying loads the steam should be watched unless supplied automatically.

When clinkers form and fuse to the firebrick lining of the producer, they must be loosened by poking from the top, and broken up as much as possible, so that they will readily work down to the grate. In poking from the top care must be taken not to injure the lining. When the clinkers have been loosened and worked down to the grate, they must be removed by working through the poke holes at the grates. All this poking and drawing clinkers off the grate must be done very carefully as a slight excess of air will decidedly affect the running of the engine. In case the producer is so badly clinkered that it will require several hours of hard work to remove them, it usually pays, where possible, to shut down the engine and work at the clinkers until removed; then a few minutes blowing of the fire will put the producer in good condition for satisfactory operation. Care must be taken not to work the fire too much, as most of the fire may be worked off the grates before all the clinkers have been removed.

One result of clinkering is the formation of holes in the fire. These cause burning of the gas in the producer, due to excess of air in this part of the fuel bed. This, of course, causes weak gas at the engine on account of too much carbon dioxide (CO_2). Holes may be formed by a caking coal, but this trouble is not so common with lignites. Both clinkering and caking can often be reduced to a minimum by working the fire oftener. Still another cause of holes is the use of coal which consists of too large lumps. When this is the case, the fuel has a tendency to hang in the producer and not feed down as readily as it should.

The writer recalls an instance where such large lumps were used that the fuel would not feed through the charging hoppers. The firemen were in the habit of filling the hoppers with the lid open, then lower the bell, and ram the lumps into the producer with a rod. This not only weakened the gas on account of too much air getting in, but in one instance a flame shot out through the hopper

while forcing through the large lumps and badly burned the operator.

The best size when using lignites is either nut or pea, mixed nut and pea gives very good results, and is readily handled in the producer. Pea alone has the disadvantage of packing more than the nut coal, and, therefore, puts the entire system under a greater suction. Unless handled carefully the pea coal will not give as economical results as nut coal, as considerable unburned coal will run through the grates or off the edges of the grates with the ash.

Two low a fire will cause the grates to overheat. The ash bed should be deep enough to keep the high-temperature zone away from the grates. Too hot a fire at the grates may also cause clinkering between the grate bars and thus prevent the free shaking of the grates as well as prevent the ash from working through. The usual cause of too low a fire is overworking the fuel bed.

The fire being too high causes overheating of the producer, which in turn causes the clinkering, and burning of the gas inside the producer. The immediate remedy is a thorough working, especially at the grate, to remove enough ashes to lower the hot zone. Too high a fire is also often caused by an overload on the producer. If the fire continuously gets too high the producer must be worked oftener at the grates; usually if the fire is in good condition, merely rocking the grates occasionally will keep the fire low enough.

The proper depth of the fire varies with different plants, depending on the length of the working day, the type of producer, the load on the producer, the quality of the coal and the method of working the producer. A careful and wide-awake operator will soon determine what depth of fire gives the best results for his plant.

An occurrence which may puzzle the operator, is the ash piling up in the ashpit, deep enough to block the air-intake pipe opening. When this happens the air supply to the producer is shut off and will cause the engine to gradually slow down, and unless remedied will finally stop it. If the plant is equipped with water-column gages the trouble can immediately be located at the producer itself by the high suction shown by the gage column. This is not a common occurrence, however, and in many types of producers could not happen.

The one thing which may cause more worry with a lignite producer than any of the aforesaid troubles is tar. At the engine this is a serious matter and must be remedied. The gas at the engine should not contain more than 0.0205 gr. of tar per cu.ft.

The first place one would naturally look for trouble when too much tar gets to the engine, is the washing apparatus. Tower scrubbers are simple in operation, but must be furnished with plenty of water. The operator must watch this water supply closely. The same holds true, with rotary, or centrifugal, gas washers. The amount of water necessary to thoroughly wash the gas is about 2 gal. per hp. per hour. When rotary washers above are used, the power necessary to wash the gas is about 4 to 5 per cent. of the load on the producer. Dirty gas may be due to insufficient power for cleaning. The gas washer may run too slow, due to improper pulley sizes or too small a driving motor; the higher the speed of the washer the more efficient will be its operation.

Tar in excess may also be due to poor condition of the fire. The fire should be hot enough to change much of the tarry matter into fixed gases and thus prevent the scrubbing apparatus from being overworked.

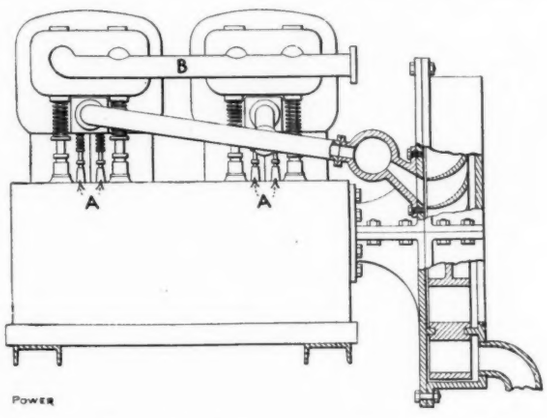
In regard to producer plants which do not give 24-hr. service but shut down for the night and Sundays, several points of special note are worth mentioning. Of course, the gas forming escapes through the purge when not operating. A slight draft should be maintained through the producer and up through the purge. If shut off entirely it will require too much time for blowing the fire when gas is wanted for running. The amount the air valve should be kept open can only be determined by trial; if kept open too much the standby loss will be too great. This must be avoided, as one of the strong arguments in favor of gas power is the small standby loss compared with steam.

If steam be supplied to the producer from some outside source, it should be shut off after shutting down the plant for the night. This should not be forgotten as the steam will deaden the fire and may extinguish it entirely.

It may not be good policy for an operator to be continuously looking for trouble, yet the operator who is always on the lookout for weak gas at the engine and poor fire conditions, is the one who will have the best operating plant.

Power from the Exhaust

That the present-day automobile engine has reached a high state of perfection is generally conceded; hence further improvement must be sought outside of the design of the engine itself. The idea of utilizing the high velocity and pressure of the exhaust gases from a gasoline engine for producing additional power has been worked out by Michael M. Sullivan, of Poughkeepsie, N. Y. His scheme consists in replacing the flywheel with a turbine wheel similar in many respects to that of a single-phase steam turbine. The shape of the blading is such, however, as to utilize both the impulse and the reaction effects. The casing surrounding the runner is bolted to the engine frame.



Turbine Wheel Attached to Gasoline Engine

The pipe which conducts the exhaust gases to the turbine attaches to the engine cylinders at a point near the end of the piston travel, and the gases pass through ports in the cylinders at this point. Valves *AA*, working off the regular camshaft, are provided so as to shut off communication with this pipe on the suction and com-

pression strokes. In order to avoid any back pressure on the engine, the regular exhaust valve and exhaust manifold *B* are provided, so that on the upward stroke the engine exhausts against the atmosphere. The valves *AA* are timed to open earlier than the regular exhaust valve. A spherical chamber is provided in the pipe leading from the engine to the turbine and serves in the capacity of a receiver.

A brake test of a small four-cylinder engine fitted in this manner, which the writer witnessed, indicated that the turbine added from 15 to 30 per cent. to the power, depending upon the speed.

At present the arrangement lacks refinement, but better results could undoubtedly be obtained by employing several nozzles through which the gas could be distributed around the periphery of the wheel. This would tend to equalize the thrust and give a more uniform turning moment. It is understood that the inventor contemplates doing this in his next machine, which will comprise a much larger engine and which no doubt will give more conclusive results.

CORRESPONDENCE

Saving in Power Cost with a Gas Engine

The choice of motive power for a moderate-sized drug and spice mill located in this city, has just been decided after over a year's experimentation and investigation. A 25-hp. reciprocating steam engine which previously ran the freight elevator, mills, grinders, etc., became so obviously uneconomical and in need of extensive repairs that the owners decided to scrap it. Temporarily, a 5-hp. electric motor was installed to run the freight elevator and carry on the most essential parts of the plant. The building itself contains six stories with shafting and machinery on the third, fourth, fifth and sixth floors. Connection with the old steam engine in the basement was obtained through belting with a jackshaft located on the second floor. The motor was installed on the fourth floor and the greater part of the shafting was cut off so that only enough remained for driving the elevator, a tablet machine and a few other small machines.

The motor remained in operation for four months, during which time the cost for electricity was $96.60. The charge was based on a rate of 12c. for the first 23 hr. use of the maximum demand and 9c. for all power used in excess of 23 hr. and not exceeding 103 hr. use of the maximum demand. Further deductions were in order for greater amounts of power, but were not applicable for the small amount of power actually used in this installation. The average maximum demand amounted to about 5 kw. during this time and, as it will be noted, was rather high for the total amount of energy consumed. The high demand charge was brought about by the large amount of power needed for starting the shafting and in running the elevator for short intervals.

It was finally decided that a gas engine would be preferable for supplying permanent motive power. Consequently, a 20-hp. second-hand gas engine in excellent condition was installed on the second floor to replace the old jackshaft previously driven by the steam engine. The entire equipment was belted to the gas engine and the new installation started on Oct. 16, 1912. By Mar. 27, 1913, the amount of gas used amounted to 122,0000 cu.ft. At the prevailing rate of 80c. per 1000 cu.ft., the cost for gas was $97.60. The cooling water used was obtained from the city mains at a cost during the specified time of $20. This cost for water is not chargeable to the engine cost alone, inasmuch as the hot water from the engine-cylinder jackets was used in carrying on other operations connected with the establishment. The average cost per month for gas and cooling water was therefore not over $21 per month against $24 for electric power. The work done during this time with the gas engine was as follows:

At least double the tablet work and press work were put through; 4200 lb. of herbs were cut in a machine which had never been operated at all by the motor; 10,000 lb. of material was finely ground and these grinders alone took at times over 12 hp. Moreover, the elevator was necessarily run considerably more during this time for conveying these materials from floor to floor.

The rate schedule for the electric energy places the motor under a considerable disadvantage because the demand charges constitute such a large proportion of the total cost. Had the actual energy used been considerably greater, that is, if there had been a steady load for long hours without a considerably greater increase of power required for starting the machinery, the motor could have competed with the gas engine on a more comparable basis. The owners also claim that the gas engine is less expensive than the steam engine. However, as the building requires a boiler installation for heating purposes and as the old steam engine was in such poor condition there is no fair basis on which to judge the merits of the gas engine and an uptodate steam engine.

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Boston, Mass.

Dust Determinations for Blast-Furnace Gases

As an interesting addition to the article in Power of May 13, 1913, on taking dust samples in gases, it may be noted that in the tests made in the South African mines by A. McArthur Johnston (Journal of the Chemistry, Metallurgy and Mining Society of South Africa, May, 1912), it was decided that powdered sugar made the best dust collector. The filter bed was made by coarsely crushing lump sugar, and using that which failed to pass through a 90-mesh (0.006-in. aperture) sieve. The filtering layer was made about two inches thick and was held in place in a glass tube by copper or brass gauze. It should be slightly moistened to aid in the retention of dust, but not sufficiently to cause caking. This point, however, must be learned by experience.

To estimate the dust, after the air was aspirated through the sugar, the sugar was dissolved in distilled water, and then the solution filtered through a tarred filter, or on an asbestos mat in a gooch. The weight found after drying represents the total dust present. Incineration will then give a loss, the organic matter.

Donald M. Liddell.

Elizabeth, N. J.

HEATING AND VENTILATION

Waste Heat from Gas and Oil Engines for Heating Buildings

In the report of the committee on steam heating presented to the National Electric Light Association, E. F. Tweedy showed that the heat available from gas and oil engines is only about 5 per cent. of that from the exhaust of ordinary high-speed, single-cylinder engines.

Several facts have militated against the more extended use of this waste heat for building heating. One difficulty has been the serious corrosion of the heaters used for extracting the heat in the exhaust gases, by the sulphurous-acid gas and moisture present in the exhaust. In certain later types of heater, however, cast iron has been substituted for steel, with the result that this corrosive action has been lessened.

On account of the high temperature of the exhaust gases—usually ranging from 600 to 1000 deg. F.—it is desirable to place the exhaust heater or boiler as near as possible to the exhaust outlet of the engine to reduce the length of exhaust piping. It is not practicable to lag the exhaust piping with heat-insulating material, as overheating of the engine would usually result; as a matter of fact, it would be desirable in most instances to water-jacket the exhaust piping between the engine and the heater.

Another reason for the limited extent to which the heat in the exhaust and in the jacket water has been utilized for building heat is the comparatively small amount of heat available from these sources as compared with the amount present in the exhaust of a steam engine carrying a similar load.

In Fig. 1 curves are given showing the approximate input of heat to gas and oil engines per kilowatt-hour of output. In this figure, curve *A* is derived from a test made upon a 75-hp. low-pressure oil engine, operating on solar fuel oil of 17,240 B.t.u. per lb. (high). The heat inputs per brake horsepower at various loads have been multiplied by 1.5 to obtain the heat inputs per kilowatt-hour. Curve *B* represents the average heat economy per kilowatt-hour for gas engines of various sizes, as given in a paper read by E. D. Dreyfus before the Pittsburgh Railway Club. Curve *C* is derived from a test made upon two Diesel engines. The points shown by circles are for a 300-hp. engine operating on fuel oil of 19,419 B.t.u. per lb. The points shown by crosses are for an engine of 225 hp. The heat inputs per brake horsepower have been multiplied by 1.5 to give the heat inputs per kilowatt-hour.

Fig. 2 shows the distribution of heat in a 225-hp. Diesel oil engine, the input of heat to which, at various loads, is given in Fig. 1. From Fig. 1 it would appear that in the Diesel engine of medium size an average heat input may be expected from 50 to 100 per cent. of rating, of about 13,500 B.t.u. per kilowatt-hour of output; while for the gas engine the average heat input through this range of load is probably in the neighborhood of 18,000 B.t.u. Individual engines of both types may vary considerably from these average figures. Fig. 2 shows that the heat represented in the exhaust, together with that lost in radiation and friction, averages about 50 per cent. of the total heat input from one-half to full load for this particular Diesel engine. Probably a figure of 40 to 45 per cent. for the heat in the exhaust alone would represent a fair average value for the Diesel engine in ordinary operation. The percentage of heat in the exhaust of the average gas engine may probably be taken at from 30 to 40 per cent. of the total heat supplied to the engine. The relative amounts of heat carried away by the exhaust and by the jacket water may vary to a considerable extent, in either type of engine, with the method of operation. Based upon the foregoing figures with either of these two types of engine there would be in the neighborhood of 6000 B.t.u. available in the exhaust per kilowatt-hour of output.

The jacket water ordinarily carries away from 20 to 30 per cent. of the total heat supplied to the Diesel engine and from 25 to 40 per cent. of the total heat of the average gas engine. These percentage figures will, of course, vary to a considerable extent, according to the amount

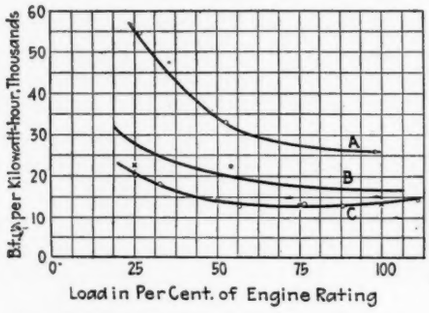

FIG. 1. TOTAL INPUT OF HEAT TO GAS AND OIL ENGINES PER KILOWATT-HOUR OF OUTPUT

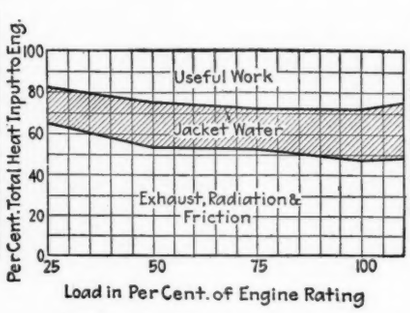

FIG. 2. DISTRIBUTION OF HEAT IN 225-HP. DIESEL OIL ENGINE

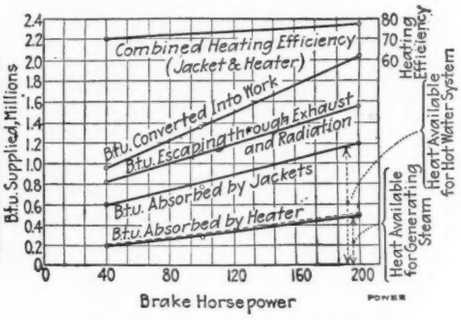

FIG. 3. RESULTS OF TEST ON EXHAUST HEATER CONNECTED TO 200-HP. GAS ENGINE

of cooling water supplied and according to its temperature.

Two distinct methods of utilizing the waste heat of gas and oil engines present themselves:

1. Heating water by means of exhaust gas either by (a) raising the temperature of the water discharged by the jacket of the engine, or (b) raising the temperature of other water, such as that in a closed hot-water heating system, without making any use of the heat in the jacket water.

2. Raising steam by means of the exhaust gases, using as boiler feed either (a) the jacket water, or (b) other water, with no attempt to utilize the heat contained in the jacket water.

Where large quantities of hot water are required for industrial purposes 1. (a) affords a means of utilizing a large percentage of the waste heat of a gas or oil engine. When a building is to be heated by means of hot water, this method would not be practicable, and 1. (b) would be the method employed.

If it were desired to generate steam in small amounts for industrial purposes, the method shown under 2. (a) might be used, although it would entail considerable complication and materially increase the cost of installation. Moreover, the saving in heat would not be great, inasmuch as only a small percentage of the jacket water may be evaporated by the heat in the exhaust gases. When steam is to be employed as the medium for heating a building 2. (b) affords the most practical method of utilizing waste heat, and this system would, under ordinary circumstances, be the most desirable one to adopt.

Fig. 3, which is reproduced from an article in POWER (issue of Apr. 11, 1911), by E. D. Dreyfus, gives the results of a test upon an exhaust heater connected to a 200-hp. gas engine. The amount of heat reclaimed by this heater for the generation of steam was shown by this test to be in excess of 20 per cent. of the heat supplied to the engine at all loads. This would be sufficient in amount to generate about 3 lb. of steam per kw.-hr. at full load, and approximately 4 lb. per kw.-hr. at 50 per cent. of full load.

The approximate pounds of steam per kw.-hr. available in the exhaust of a steam engine and that available from heat in the exhaust of a gas or oil engine are as follows:

Simple automatic engine	60
Single-cylinder Corliss engine	42
Corliss noncondensing compound engine	33
Gas or oil engine, exhaust used for raising low-pressure steam	3

Accordingly, it will be seen how insignificant is the amount of steam that may be generated from the waste heat in the exhaust of the average internal-combustion engine when compared with the amount of exhaust steam obtainable from the ordinary simple automatic engine.

Possibilities of Hot-Water Heat*

Hot-water heat has many possibilities from a financial standpoint, but many things affect the earning power of the plant, among which are the design of the plant, the way it is put together, the relation between the electrical load and the heating load, the particular way that the bookkeeper figures the profits or keeps the books, the rate charged for heat, the method used in figuring radiation and the condition of the pipe lines.

*Abstract of paper read by N. M. Argabrite before the National District Heating Association, Indianapolis, May 27, 1913.

Some engineers turn the exhaust from an engine into an open heater or drum equipped with spill pans, and by splashing the return water of the heating system down over these pans absorb the heat in the steam. Another method is to use a set of small upright inclosed heaters with copper or brass tubes, passing the steam into the chamber and the circulating water through the tubes, and allowing the condensate to run out through a drain line.

An improved method over the first mentioned is to exhaust into a jet condenser, thus forcing the water to take up the exhaust steam and oftentimes giving a fair vacuum on the prime mover.

A better method is to exhaust the steam from the prime mover into an oversized heating condenser. The heating water is circulated through the cooling chamber and a dry-vacuum pump and hotwell pump are used to obtain all possible vacuum on the prime mover. The condensate is saved for boiler feed.

The way a hot-water heating plant is put together has much to do with its success. Many spill-pan systems come to grief from cylinder oil working its way into the heating mains, then into the services and radiators and eventually clogging up the system, although an efficient oil separator will tend to eliminate the trouble. This same objection may be offered to jet-condenser systems.

The relation between the electrical load and the heating load greatly affects the earning capacity of a hot-water plant. To say the least there is no large amount of money in the hot-water heating business—or steam either, for that matter—when the plant has no other product, such as electricity. It stands to reason that the more heat that can be obtained from exhaust steam the better from a financial standpoint. It then becomes a question of proportioning the heating plant to the electrical load, or *vice versa*.

A heating system designed to absorb all the exhaust in November will surely have three months of live steam use. A certain amount of live steam is not a bad thing when its use does not come too often, and still allows the spring and fall steam to be turned into more money, but the best advice to the man with a hot-water plant requiring too much live steam is to get busy and load down the electric end. It is possible at this day and age to put one electric consumer on the lines for every five people in the city.

The objection might be raised that the lighting load gives peak customers who would furnish relief only for a few hours per day, but right here is one of the main advantages of hot-water heat; namely, that the heat does not pass off immediately as with steam. The pumps can be stopped in the dead of winter for several hours and the customers will not suffer. The author had one line off last winter from 2 p.m. to 6 p.m. and nobody on the line had complained up to 15 min. of the time service was resumed.

The ideal relation between electric and heating loads is found in larger cities, where there are one or several other plants working in connection with a heating plant or plants. With these conditions the electric load becomes elastic and can be made to fit the heating load.

The particular way that the books are kept has much to do with the plant earnings, and can in many cases make the hot-water plant a paying or losing investment. Is the heating plant charged with all coal and all plant

labor, giving credit for current at wholesale or retail rate? Some may think the coal cost for summer months should be wholesale and others that it is only fair to charge heating with all above the summer kilowatt cost. If this is done, then what about the larger peak in winter calling for more engine units which often raise the cost per kilowatt-hour? Also, what about the hot-water plant which really reduces the cost per kilowatt-hour by making an otherwise noncondensing plant condensing? This is another important advantage of a hot-water system.

Hot-water heat generally sells by the square foot of radiation per season, and the rates for this service range from 15 to 25c. per sq.ft. per season. Naturally a great deal depends upon this rate and upon how fair a rate a company has for its location. A 25c. rate in Minnesota is no better than a 20c. rate in Ohio, all other conditions being equal.

The condition of the pipe lines has much to do with the overall economy. A small leak in a hot-water main will eat up many feet of pipe each season. Most of the pipe depreciation takes effect on the outside and is caused either by leaky pipes or by outside water getting into the boxing, principally the former. Many hot-water men brag about doing heating with water at the temperature at which the steam man's condensate is going to the sewer, but that same man may have a make-up pump in his plant, supplying as much make-up water as is going into the boilers or even more.

In the opinion of the writer, the greatest possibilities in hot-water heating lie in improving and bringing uptodate the present systems.

Among the possibilities referred to are the following: Cleaning out some of the wasteful auxiliaries; getting rid of open heaters and installing heater condensers, thus making the plant condensing; installing thermostatic control on the services; improving the pipe insulation; reducing excessive circulating pressures; closing every leak on the system, and many others.

In looking over the pump room of a hot-water company the author counted ten steam pumps going at one time. Some of these pumps could have been easily eliminated. It is on this point that most companies make their greatest mistake. The man in charge of the above mentioned plant said that the extravagance of these pumps made no difference as they needed the steam for the heat anyway. A test upon his circulating pumps showed a steam consumption of about 150 lb. per hp.-hr. How many operators would run a generating set very long if it took half as much steam? It takes between 25 and 40 hp. to circulate water for a system of 100,000 sq.ft. Suppose the pumps were changed to electric drive. Motors would then be employed requiring about 40 lb. of steam per kw.-hr., or 30 lb. per hp.-hr. This would save about 120 lb. of steam per hp.-hr., meaning for an ordinary 100,000-ft. system using 30 hp. about 3600 lb. of steam per hour. This quantity of steam will make in the average small plant about 90 kw. per hr., which will mean in 200 days, 432,000 kw.-hr. Kilowatts have a market at some price. If the wasted steam mentioned above is needed on the heat peak it will not be required during the remainder of the season. Taking the average income from power at about 3c. per kw.-hr., 432,000 kw.-hr. at 3c. would bring $12,960, 6 per cent. interest on $216,000. In coal alone at $2.10 per ton the change would save $2000.

There may be many chances almost as good as the above for making large savings. It is desirable to save the condensate for boiler-feed water, to run the engines condensing and perhaps circulate the water in the system more slowly. All of these things can be done by installing a large oversized heater condenser with a vacuum pump and hotwell pump, allowing about 5 ft. of condensing surface per kilowatt of maximum load.

Assume an engine drive taking 40 lb. of steam per kw.-hr., and a daily load of 5000 kw.-hr. supplying heat to 100,000 sq.ft. of radiation. Surely a vacuum averaging 21 in. will save at least 15 per cent. of the steam needed to drive the engine. At 40 lb. of steam per kilowatt-hour and 200 days per season, 5000 kw.-hr. per day would require 40,000,000 lb. of steam. An evaporation of 8 lb. would call for 2500 tons of coal, which at $2.10 per ton would cost $5259. Then 15 per cent. of this figure would be $787.50, the amount actually saved in coal.

The condensers previously referred to are on the market and what is more they will do what is claimed for them. It is possible to get an outboard temperature of 130 deg. with 115-deg. return water and have a 25-in. vacuum; 140-deg. water, 120-deg. returns, 23½-in. vacuum; 150-deg. water, 130-deg. returns, 21½-in. vacuum; 160-deg. water, 140-deg. returns, 18½-in. vacuum; 175-deg. water, 150-deg. returns and a 15-in. vacuum.

These figures can be bettered by slowing down the circulation and bringing the returns back colder.

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Heating and Ventilating in Europe

In Germany, states a consular report, during the last 10 years the installation of hot-water and steam heating, and for large buildings the necessary ventilating facilities in conjunction therewith, has made enormous strides.

The high cost of raw materials, both for combustion and the heating plant itself, has necessitated greater economy in installing and daily operation; hence the obvious reason for their greater advance along these lines. Scientific study has enabled Germany advantageously to compete with all foreign competitors, not only in their own country but in most others where tariff restrictions are not too great.

The fuels mostly in use are coke and a noncoking brown coal (lignite), the former being a byproduct of gas works and reducing ovens and the latter a very cheap form of soft coal low in heat units. The cheapness of this fuel has resulted in overcoming the difficulties of obtaining efficient combustion with such a poor class of fuel.

All towns and cities are governed by a general and very strict smoke ordinance, which applies to house heating as well as power boilers. At the same time all cheaper classes of fuel, especially of the lignite variety, tend to give a noxious and easily detected smoke when the combustion is not complete. Hence great difficulties have had to be overcome in manufacturing boilers to give satisfactory and economical service and at the same time to comply with the laws governing their operation.

House-heating boilers for both steam and water systems are sold on a basis of heating surface, the average price being 50 to 70 marks ($11.90 to $16.67) per sq.m. (10¾ sq.ft.) heating surface, depending on the size and quality. Radiation, on the same basis, costs 6 to 7 marks ($1.43 to $1.67) per sq.m. heating surface. It is usual to assume an additional 20 per cent. to cover the cost of installation.

EDITORIALS

The Steam Turbine for Auxiliaries

Time was—and not long ago—when the use of steam turbines for driving auxiliaries was considered to be poor engineering because of the high steam consumption of these units. There are those who still believe that the small turbine is too wasteful of steam to warrant its use.

The experience of engineers in large plants where the auxiliaries are numerous, leads them to favor the turbine for auxiliary drive because its overall economy is better than is practically possible with reciprocating engines. While the steam consumption of the turbine is usually greater, its low cost for maintenance, oil and repairs, and, consequently the lesser amount of skilled attention required for its successful operation, offset the higher water rate. It must be remembered, too, that the exhaust steam from these small turbines is returned to the feed-water heater, and thus much of the heat supplied to the machines is returned to the boilers without an appreciable dead loss.

The development of the modern centrifugal pump is having a marked influence on the field of the small turbine. Centrifugal circulating and boiler-feed pumps that may be easily accommodated to turbine speeds are becoming more and more popular, not solely because of the little floor space occupied, but because they are not so subject to disorders, as those of the reciprocating type.

It is known that the efficiency of steam turbines, large or small, decreases as the blades are worn by erosion. It is important, therefore, that small turbines as well as large ones be supplied with steam that is reasonably dry. Troubles due to the erosion of turbine blades are not so numerous or costly now as they were a few years ago, owing to the use of metals that better resist the erosive action of the water.

Some Causes of Flywheel Explosions

Every little while an account is published of a flywheel explosion, the cause of which is unknown. Nevertheless, no flywheel will burst without a cause. If it is discovered a second accident from the same source is not likely to occur; if the real cause is not ascertained another flywheel accident may take place.

Few engineers realize that the rims of most engine flywheels have a velocity of approximately one mile per minute, which is considered safe. If the engine speeds up a few revolutions the rim velocity exceeds the safe limit and approaches the bursting point.

The energy stored up in a revolving flywheel is tremendous and if suddenly released, will result in widespread havoc. Under ordinary bursting conditions the rim of a flywheel has a velocity of approximately three miles per minute, which accounts for the fact that most bursting flywheels are completely demolished upon rupturing and the pieces are thrown through thick walls and for considerable distances.

The menace from flywheel explosions is unfortunately not confined to destruction to property, but generally involves the death or injury of one or more of the employees about the plant.

Governor derangement of one kind or another is probably the direct cause of more flywheel accidents than can be attributed to any other. It may be that the governor belt broke or ran off the pulleys, and the governor was prevented from operating the safety cams, because the stop pin had been left in position.

An exhibition of this kind of carelessness was witnessed just recently. The engine was new, and equipped with a safety stop, but notwithstanding the ingenuity of the inventor and the expense of making it, so that the engine would be safeguarded against overspeed, the running engineer had plugged the stop with a piece of wood, making it inoperative and defeating the purpose for which it was intended.

Overload is another cause of flywheel rupture, when the engine is belt connected. Generally the rim of the wheel is made thin and is, therefore, likely to fail, not only from centrifugal force, but from a short-circuit of the electric generator, if used, a sudden stoppage of the engine, or the sudden throwing on of heavy machines in the mill.

The greater the velocity of the rim of a flywheel the lighter it can be constructed and still prevent fluctuations in engine speed. There is a tendency on the part of the engineer to run an engine to high rim speed in order to obtain additional power from an engine and wheel designed to do less work. Such a wheel is more likely to rupture from overload than if it had been designed with a heavier rim. When speeding up an engine to obtain more work the engineer should not neglect to take the strength of the rim of the flywheel into consideration.

Public Service Commission's Power-Plant Rules

On July 1, the rules drawn up by the Public Service Commission for the protection of employees of public-service plants, for the First District of New York State (New York City) went into effect. A list of these rules was published in POWER for June 17, page 880.

Among the rules, five are especially important, namely:

(8) All stop valves on steam boilers shall be of the automatic self-closing type.

(10) All furnace doors on hand-fired boilers shall be fitted with latches or catches to prevent them from being blown open.

(12) All large main cutout stop valves shall be provided with means whereby the same may be closed from the boiler or engine-room floor or other remote point.

(13) All large steam units shall be fitted with automatic self-closing valves.

(14) All high-speed engines shall be fitted with automatic safety stops.

These rules are indeed excellent. It is to be regretted that their application is so limited. As is generally known, they apply only to public-service corporations, for the Public Service Commission has no jurisdiction over private plants. Steam boilers or engines and their piping carrying high-pressure steam are no less dangerous because they are in a plant other than a public-service plant. In fact, the opposite is true, as a comparatively greater number of serious accidents happen in manufacturing than in large power-house plants, chiefly because manufacturers are so reluctant to equip their plants with safety and labor-saving devices.

There is strong opposition to these rules in some quarters, and there are likely to be interesting developments before the commission succeeds in enforcing them in all public-service plants in the First District. Some of the more modern plants have automatic stop valves on boiler leads and on steam lines to the main units; the high-speed and other engines have automatic stops. Plants so provided will not be under heavy expense to meet the requirements of the commission's rules. But companies that have several plants aggregating one or two hundred boilers, none of which have automatic stop valves, will have to spend a goodly sum to comply with the rules. The expense of furnishing automatic valves to the boilers is not all that must be met, but it is the largest item.

It would not surprise us if some of these last named companies should object to the rulings on the ground that they are discriminatory. Their logical contention would be, as we stated, that high-pressure boilers and piping are no more dangerous in one place than in another and, therefore, the rules relating to automatic stop valves and furnace doors should apply to all plants or to none.

Such a controversy would undoubtedly lead to the commission recommending a state law embodying their rules that would apply to all plants.

A few months ago we recommended, editorially, that states or municipalities creating laws enforcing the use of automatic nonreturn stop valves, should make it compulsory to put in these valves in new installations or when remodeling an old plant or renewing a stop valve. At least they should allow a reasonable time within which the change from the old-type valves must be made. In this way no undue hardship would be worked on any plant, all would be equitably treated and the old valves would slowly but surely become obsolete.

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Over-Specialization

More than in many other callings, the fascinating details which form so large a part of the engineer's work tend to make him an extreme specialist. The economical production and utilization of power is in itself a broad and rich field in which to turn one's best energies to useful account; but important as is this branch of engineering, it is a means to an end, and a keen perception of that end forms a mighty good platform upon which to stand in looking toward larger responsibilities and greater rewards.

In these days it is needless to dilate upon the value of the specialist in the doing of the world's work—the necessity for the man with deep, acute knowledge in particular and often difficult branches is self-evident. But the world also needs, and finds none too common, the man with the analytical power of the specialist and the constructive ability of the able technical executive. Those who can qualify seldom remain on jobs with no futures. How to qualify is the big problem.

A technically trained engineer has constantly to combat a tendency toward narrowness of viewpoint if he desires to cultivate a wide mental horizon. He has to avoid a complete absorption in detail to the exclusion of the larger relations of his work if he will advance along broad lines, and still he must not neglect details which are essential. The man with the capacity to see the unusual and the significant, the chap with imagination and enterprise enough to look at the relations of his own duties to the welfare of the concern as a whole is the one selected to go higher when the inevitable changes of industrial life come.

Over-specialization often leads to undue emphasis upon the importance of individual tasks in given departments; to a lack of interest outside immediately vital responsibilities; to long continued employment at stated compensation perhaps, and not seldom to final replacement before middle age is past by men with less experience in single grooves but with better comprehension of interdepartmental relations and the ability to make effective use of men with limited ideas.

The engineer should regard his department as a link in the chain—a mighty important link, but a part in the whole scheme of organization, representing, in the case of a power plant, probably not over five per cent. of the total cost of production, and the less this percentage the better, by the way. While keeping up an intense interest and activity in the detailed work of each day, he should look for their significance in the mass. If his company is given a hearing upon its rates or a stock issue before the state commission, he should try to secure the record of the testimony and study the company's operations from a new viewpoint. These records are practically always open to public use at the commission's office, but no liberal manager will deny his employees the opportunity to read such records within the plant itself, if the request is made in good faith. The engineer should make as careful a study as possible of the workings of all departments, the public policy, commercial methods and general administration of his organization; the time required will be well spent in the interests of a larger efficiency and broadened outlook.

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In the past year an investigation has been made of every accident that occurred on the Pennsylvania Railroad. To give all employees the benefit of this investigation, a book has been compiled, "Safety Hints and Suggestions for the Prevention of Personal Injury Accidents," and copies distributed among them.

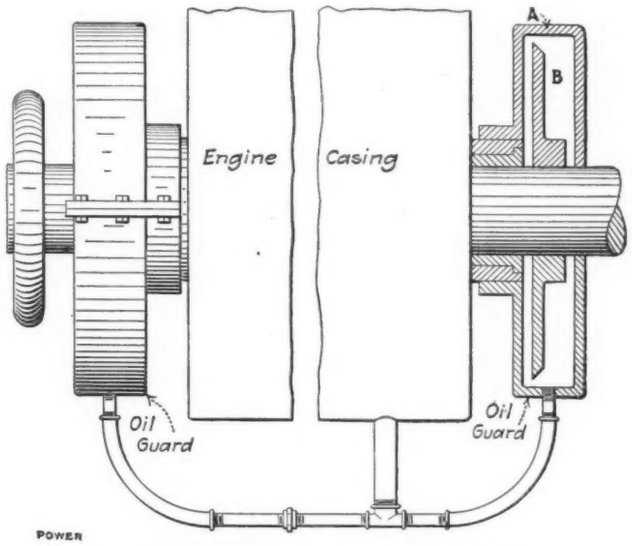
It would be splendid if some such service could be done for power plants generally. At least they may profit by this thought that is expressed in a message from the general manager accompanying the book:

"Safety in railroad operation is not a question of safeguards, but of intelligent caution constantly exercised. The ultimate aim of the safety work is to develop in each employee a sense of personal responsibility, not alone in taking measures for his own safety, but for that of his fellow employee as well."

READERS WITH SOMETHING TO SAY

Baffles Save Much Oil

In marine practice one has more or less trouble with oil that runs from the bearings, etc., down the outside of the machines, then to the deck and, unless the oil is kept wiped up, it makes an objectionable mess. Our worst trouble was with eight force-draft blowers; they were inclosed in an oil-tight casing so that the cranks, main bearings and crossheads were oiled by the splash system. These engines ran nicely, seldom needing any unusual attention, but oil would get through the sides of the main bearings and besmear the blower with oil, besides crawling along the shaft at both ends and when it reached the starting wheel it would fly off in all directions with considerable force as the blowers ran at 800 r.p.m. This was partly overcome by fitting hoods over



CRANKCASE FITTED TO AVOID OIL LEAKAGE

the starting wheels. The fan end was more difficult to control as the oil would get through the fan casing where the shaft went through, and the fan would throw it all over the top of the boilers. This wasted 4 gal. of oil a week for each blower and the trouble lasted for a long time, during which many devices were tried but without satisfactory results.

An oiler said that he had solved the oil problem and he produced the sketch shown. Both oil guards *A* and oil baffles *B* were made in halves so that they could be bolted together without removing the shaft fittings. The bottoms of the guards were connected to the bottom of the oil well. We had patterns made and received four sets of castings before sailing, fitting them up on board, as illustrated. This ended our troubles, besides saving nearly a barrel of oil each trip.

K. D. GRANGER.

Philadelphia, Penn.

[This same arrangement of baffle and casing is applicable to any shaft.—EDITOR.]

Pump with Hydraulically Operated Suction Valves

Discussions relative to troubles attendant upon handling hot water with direct-acting steam pumps, recalls an experience which resulted in disappointment to the inventor of a hot-water pump. An engineer had in service a duplex steam pump and receiver, handling heating returns to the boiler on a closed system. Under ordinary circumstances the mechanism operated perfectly, but peculiarly enough, with a falling boiler pressure, a condition sometimes existed which caused the pump to become vapor-bound, run away and almost pound itself to pieces. This trouble invariably occurred at night, during the engineer's absence.

After much thought and some experiment, it was determined that a vacuum was formed in the receiver when a small quantity of cold condensate was returned to the receiver. This prevented the water from flowing down into the pump cylinders, for some reason or other, which

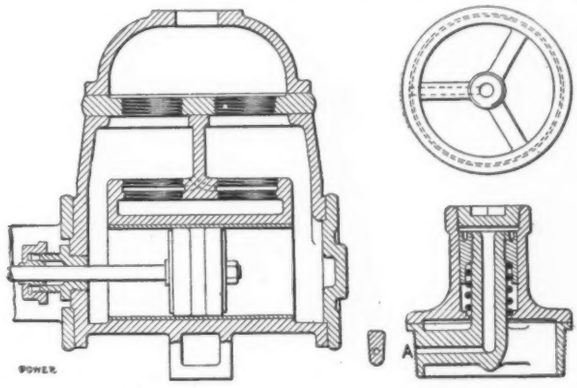


FIG. 1 FIG. 2

SECTION OF PUMP AND DETAILS OF SUCTION VALVE

in turn caused the pump to become vapor-bound. It was reasoned that if the suction valves of the pump were automatically operated, this condition could not occur.

A manufacturer was finally found who built a pump to the inventor's design, as shown in Fig. 1, equipping the pump with automatic suction valves, as shown in detail in Fig. 2. The suction valves are hydraulically actuated, being lifted off their seat by the pressure in the discharge space at the opposite end of the cylinder, water under pressure entering at *A*, Fig. 2, and flowing into the cored ports.

Strange to say, even this arrangement, presenting a free port through which the water from the receiver could flow to the cylinders by gravity, failed to prevent the pounding. The pump operated just as badly with the automatic valves as with the ordinary pump valves, though the reason for the failure has always remained unknown. An itinerant "pump doctor" suggested piping a cold water injection line to the cylinders to condense the vapor and prevent the pump from slamming. This

expedient proved entirely satisfactory, the introduction of a very small quantity of water proving entirely adequate to stop the pump's running away.

No pump and receiver can be operated on a closed system without danger of becoming vapor-bound, no matter where the receiver may be located in reference to the pump. As a matter of experiment, a receiver 15 ft. above the pump has been tried, and it has been found that the pump could be made to run away by the injection of a small spray of cold water into the receiver. In practically every case, an injection of cold water into the pump cylinders entirely prevents this trouble.

H. B. Goodwin.

Holyoke, Mass.

Pitting of Boilers Due to Furnace?

The pitting of boilers in Chicago seems to be quite characteristic to boilers having the dutch-oven type of furnace. The object of installing this type of furnace is to eliminate the smoke, which it does after the furnace gets hot.

There are about three thousand firebricks used in the construction of such furnaces, so it is readily realized how much heat they retain after the fires are drawn or burned out. On examination of the inside of the boilers the next day or so after the fires have been drawn and the steam is down, it will be found that the heat from the furnace generates a vapor in the boiler and when the vapor condenses on striking the top plates it forms small drops of water which cling to the shell until they become heavy and drop on the bottom plates. During the time the drop is forming a chemical action seems to take place. This chemical, which seems to be heavier than the water, and wherever it drops settles on the flues or shell and pitting takes place. This action does not occur in other boilers that use distilled water, but have not that kind of a furnace.

E. Herzog.

Chicago, Ill.

A Unique Explosion

Two boilers, 60 in. by 16 ft., of the horizontal return-tubular type, each rated at 80 hp., were recently installed in the basement of a new addition to a building in Chattanooga, Tenn. The settings were of the steel-cased type, and the boilers were set entirely independent of each other.

Boiler No. 2 was fired up, and after the setting had time to get hot, an explosion occurred, supposedly in the setting. Very little apparent damage was done. The fire-doors were blown open, the rear soot door blown out of position, the ashpit torn up to a depth of 2 or 3 in. and the grates disarranged. No careful examination was made, as the attendants supposed the explosion was the result of the sudden ignition of a collection of gas in the furnace. As the fire had been started merely for the purpose of drying out the setting, it was not restarted.

On the following day, the damper and draft doors of boiler No. 1 were opened and the setting carefully examined to prevent a recurrence of the accident of the day previous. A fire was then started under this boiler, and after the setting had become hot and ashes and hot coals had deposited in the ashpit in sufficient quantity to thoroughly heat it, an explosion occurred similar to the one that had occurred under boiler No. 2, but of more serious moment. The fire-doors were blown open, rear soot door blown out of position, ashpit torn up to a depth of 6 or 8 in., and the grates were hurled up against the boiler and fell down in disorder into the ashpit.

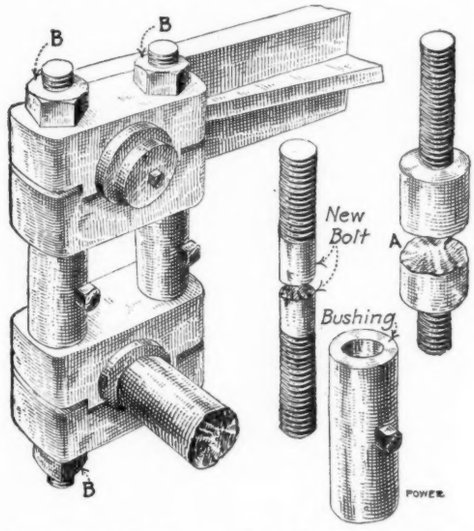
A boiler inspector was notified of the explosions and hastened t the scene. He proceded immediately to make a thorough examination, and found that the explosions were not from gas in the furnaces, but that they had occurred under the ashpit, the bottoms of which were formed by the concrete floor of the basement. The conclusion was that the steam had been generated from the excessively damp soil under the concrete, or from water that had soaked through cracks or apertures which had been closed by the expansion of the concrete as it became hot, and there was left no avenue of escape for the steam. As water had stood in the basement, both before and after the concrete floor had been put in, the conclusion was logical, and at once accepted by all concerned.

D. A. Simpson.

Chattanooga, Tenn.

Repairs to Link of Pump

A bolt broke on one of our air pumps, and caused a shutdown during the time the repairs were being made. The bolt was of peculiar construction, as shown at *A*, and



Showing New and Old Bolts for Link

to remove it we had to disconnect the pump. It was the first of its kind to be broken, and none were in stock.

We made an improvised bolt with a piece of pipe and started the pump. We made new bolts, but of a different design than those furnished by the pump makers. The old bolts *A* were in one piece, large in the middle to provide shoulders on which the bottoms of the bearing caps could rest while the nuts *BBB* were tightened. The construction of these old bolts made it necessary to take the link apart when a bolt broke.

To avoid doing this the new bolts were made of the same diameter throughout their entire length and a sleeve, made f a piece of pipe through which the bolt was inserted, provided the necessary shoulders.

Fall River, Mass. Robert Colbert.

QUESTIONS BEFORE THE HOUSE

Rubbish as Fuel

In the issue of May 27, there appeared on Page 745 an editorial on burning of waste materials where coal was the principal fuel. On the other hand, I have burned thousands of cords of waste material where the latter constituted the main fuel, and where coal was advantageously used for improving the combustion of the waste material. For this purpose a few shovelfuls of coal spread over the fire and worked below the bed of waste fuel have proved very satisfactory in preventing fine material like sawdust from falling through the grates and in ventilating the bed of fuel. Quite large lumps of coal may be used; in fact, old firebrick or large clinkers from the ash pile can be used in the same way to good advantage.

In my opinion the old-style straight grates with 3/8- to 1/2-in. openings and a layer of clinker spread over the grates to keep the waste fuel from falling through are far better than any of the special designs of grates for burning sawdust that have come under my notice. Sawdust laid on a bare grate makes too close a bed for obtaining a good draft and will only burn from the ventilated surface inward. It therefore needs to be broken up to expose as large a surface to draft as possible, but the bed should not be disturbed any oftener than necessary or the fire becomes smothered. All the cleaning that is necessary is to take a single-pronged hook laid flat on the grates and rake it back and forth a few times during the run. After cleaning a sawdust fire in this manner the heated clinker or lumps of coal will cause the bed of fuel to be quickly ignited and for the same reason that combustion of a sawdust fire is always active next to the hot walls of the furnace.

V. L. Ballou.

North Adams, Mass.

Water-Column Blowoff Piping

In the June 3 issue appears an editorial note attached to the article of Edward T. Binns, a part of which reads, "It is hardly to be recommended that the column blowoff be piped elsewhere than to the ashpit."

I wish to take exception to this statement. It is true that it is common practice to run a 1/2-in. pipe from the column to the ashpit, to be used as a column blowoff, but this is not good practice, for several reasons: First, the function of this blowoff is to keep the lower connection from the boiler to the column free from sediment. With a small pipe this cannot be effectually done as the amount of water passing through the small pipe is not sufficient to move the water in the larger pipe (which is usually 1 1/4 in.) fast enough to thoroughly clean it.

My practice is to make the column blowoff equal in size with the lower connection and to connect it around into the boiler blowoff pipe. In this way a full 1 1/4-in. opening can be had, and things have got to move when the valve is opened. My method of column blowoff connections meets with the hearty approval of all boiler inspectors who visit the plant.

There are other minor reasons why this blowoff pipe should be kept out of the ashpit, such as the possibility of accidents such as happened to Mr. Binns; the deterioration of the bridge-wall caused by the blowing of steam and hot water forcibly against it, etc.

E. H. Roberts.

East Norwalk, Conn.

Engine-Cylinder Lubrication

In reading the article on the above subject by Willis Lawrence in the May 10 issue of Power, I was deeply interested in noting the beneficial effect of the graphite in the oil. It would be of interest to know what amounts of graphite were found to be sufficient to take the place of the varying per cents. of animal fats, and whether the same methods of lubrication can be used for feeding graphite and oil as is used for cylinder oil alone.

The subject is of such vital nature and so little definite information is at hand that the publication of such articles as "Engine-Cylinder Lubrication," as well as discussion should be of great value to engineers.

John W. Hacker.

Gary, Ind.

Ammonia and Water for Hot Bearings

I have just read the article in the Apr. 1 issue of Power relative to the use of ammonia for cooling hot bearings. While I have never expanded liquid ammonia directly into the bearings, I have expanded it into a 5-gal. can of lubricating oil until we had nothing but a lather which was remarkable for its cooling properties, and which fed very fast through the gravity-type oiling system. This lather cools the bearing very quickly. The bearings were 9 1/2 in. in diameter by 9 1/2 in. wide, of solid bronze, and they were chronic "heaters." Cooling them with this lather enabled us, in three instances, to operate until Sunday morning, when repairs could better be made. No ill effects were noticed from the use of the ammonia.

To show that it takes considerable time for ammonia to attack bronze and brass, the following experience serves well: Two brass valves and a brass union were placed in a liquid-ammonia line, the intention being to use them for a day or two until regular ammonia fittings could be procured. But it was three months before they were removed, and the valves and unions were then as good as new, being much cleaner inside than when first installed.

I should not fear the effects of ammonia for such few times as it may be applied to bronze bearings. And, as for babbitt, ammonia will never harm it. As for applying water on a babbitted bearing that is running fairly well, do not do it. The result is generally a slight roughing of the surface, forming little waves in the oilways,

which become filled with black flakes. Use plenty of water and oil on bronze bearings as a polished surface and a cool-running bearing result, but keep water off the babbitted boxes. The above has been my experience in rolling-mill and blast-furnace work.

D. L. FAGNAN.

Amarillo, Tex.

How Did It Happen?

Replying to F. A. Hunter's inquiry, page 426, Mar. 25 issue, as to how it happened that the exhaust valves of his Corliss engine became turned upside down, if the valves had originally been put in right side up, then with the reach rod unhooked it is possible that the lengths of valve rods and valve arms are such that by moving the wristplate far enough the valve arms could have become turned upside down, thus turning the valves bottom side up. Mr. Hunter should take diagrams to determine whether the exhaust valves are working right by merely turning them right side up or whether the valve arms became turned upside down, thus causing the valves to be turned bottom side up. In this manner he may come to a conclusion of how it happened that the valves were found to be upside down.

THEODORE C. ROBINSON.

Fort Madison, Iowa.

Centrifugal Pumps for Boiler Feeding

In these columns there has recently been some discussion on the use of centrifugal pumps for boiler feeding. It might be of interest to some of the readers of POWER to know that on a certain ship, running regularly on the Pacific Coast, there are in use two centrifugal pumps, 2½-in., four-stage, direct-driven by steam turbines. These pumps feed boilers 16 ft. in diameter by 11½ ft. long, working under 200 lb. pressure. The supply is taken from a filter box under a 5½-ft. head, the hotwell temperature being 110 deg. F. The steam to the pumps is controlled by a chronometer valve and float which is located in one compartment of the filter box, and operates automatically with a lever connection between the float and the chronometer valve. The delivery from the pump is discharged into a filter of the cloth-covered type, thence to a closed heater and finally to the boilers.

These pumps run at 3000 r.p.m. and in addition to the float control, have a Pickering governor located at the turbine throttle. This, of course, would be brought into action and immediately shut off the steam, should anything happen to the float governor.

J. A. MCVAY.

San Francisco, Calif.

Experiments on Efficient Boiler Operation

In his article on this subject, page 799, June 3 issue, B. W. Rogowski says regarding the unavoidable losses in dry chimney gases:

"Assume the air supply to be theoretically correctly proportioned to the amount of coal burned, i.e., 11.5 lb. per pound of combustible; atmospheric temperature, 60 deg. F.; stack temperature at the base, 450 deg. F.; specific heat of the flue gases, 0.24. Then the heat carried away by the least possible weight of chimney gases with perfect combustion and conditions specified above would be

$$[(11.5 + 1) \times (450 - 60)] \times 0.24 = 1170 \text{ } B.t.u.$$

"With fuel having a calorific value of 12,500 B.t.u. per pound this means an unavoidable loss of

$$\frac{1170}{12{,}500} \times 100 = 9.36 \text{ } \textit{per cent.}"$$

His figure—9.36 per cent.—is incorrect, for after obtaining 1170 B.t.u. as the loss per pound of *combustible* he should have divided by the heating value of a pound of combustible, which with the fuel considered, would be about 14,500 B.t.u. This gives

$$\frac{1170}{14{,}500} \times 100 = 8.07 \text{ } \textit{per cent.}$$

CHARLES C. COBB, JR.

Kewanee, Ill.

Electric Elevator Question and Answers

In the June 10 issue, Mr. Pyatt, in criticizing my article under the above heading, states that in his experience the car operates the limit switch. This may be true in his individual plant, but if he has seen elevator equipment in many plants he will agree with my statement that when the car is down below the bottom floor the counterweights are up at the top where there are two limit switches, one for the car when it is at the top and one for the counterweights when the car is at the bottom; both switches will break the circuit and stop the motor.

Mr. Pyatt claims that by holding the potential switch in place the car may be moved quicker. He neglects to state that with most electric elevators this will require an extra man to hold down the clapper switch on the back of the brake band. As a matter of fact, neither of these methods is the quickest. By simply putting a piece of ½-in. iron under the brake spring and raising the brake-band weight arm, the car will rise unaided if the load is off. He does not see why an elevator should make a sudden stop on the up stroke and not on the down stroke. If he will study the illustration accompanying my article "Care of Electric Elevator Brakes," POWER, Oct. 8, 1912, page 539, he will be enlightened. I often wondered why this is so, but after working on several brake connections I find that it requires a certain tension on each of the brake bands to get a good, easy stop, both on the up and down motion. There are 16 elevators in our plant, so we get plenty of experience.

Mr. Pyatt does not see how the safeties can be loosened without pulling out the governors. Here is where experience and actual familiarity with the machinery under one's care counts for much. All that is necessary is to raise the car about a foot with the spanner wrenches and the governor ropes will be very slack and will allow the spool under the car to be turned off. It is not necessary to pull out the governor until the safeties are out. Mr. Pyatt further states: "When the centrifugal governor trips (which it can only do when the car is on the down trip), etc." If he will visit a few plants he will, no doubt, see electric elevator governors that operate both on the up and down trips.

A. C. WALDRON.

Revere, Mass.

INQUIRIES OF GENERAL INTEREST

Pump Lift Through Different Sized Pipes—When two steam pumps of the same design and size are working with 100-lb. steam pressure, one having a 3-in. discharge pipe and the other a 6-in. discharge pipe which pump will force water to the greater height?

A. S.

The pumps would force water to the same height, but the pump having a 6-in. discharge would work faster and would pump more water in a given time. The pressure exerted by the water piston would be the same in each case and without friction there would be only the same velocity of discharge, and the 6-in. pipe having four times the cross-sectional area of the 3-in. pipe, the latter would discharge only one-quarter as much as the former in a given time. When friction is considered it is to be seen that the 3-in. pipe would discharge less than one-quarter as fast, because a larger proportion of the initial pressure would be lost in pipe friction, leaving less pressure available for production of velocity.

Boiler Evaporation—How many pounds of water can be evaporated from one pound of coal of a heat value of 12,238 B.t.u. per lb. in a boiler having an efficiency of 85 per cent.?

P. J.

The heat units effective in evaporating water will be

$$12{,}238 \times 0.85 = 10{,}402.3 \text{ B.t.u.}$$

The weight of water evaporated per pound of coal would depend upon the feed-water temperature and the boiler pressure. These conditions are not stated. Whatever the conditions the equivalent evaporation, i.e., from and at 212 deg. F. and atmospheric pressure, will be

$$\frac{10{,}402.3}{970.4} = 10.72 \text{ lb.}$$

For any other conditions this figure should be divided by the factor of evaporation applying. For instance, with a feed-water temperature of 200 deg. F. and a boiler pressure of 100-lb. gage, the factor of evaporation would be (from tables in engineers' pocketbooks) 1.052 and the actual evaporation

$$\frac{10.72}{1.052} = 10.19 \text{ lb.}$$

per pound of coal.

Indicating Through Drip Cocks—To find the indicated horsepower of a slide-valve engine, which is not tapped for an indicator, can I connect the indicator piping to the cylinder-drip connections and get fairly accurate results?

H. W. C.

While this is not to be recommended as regular practice and is discouraged by instrument makers, it can be done under necessity, but certain precautions must be taken to get reasonably accurate diagrams. Quoting from "Inaccuracies of Indicators," by James G. Stewart ("Power," June 17, 1913, page 851), "A chief source of error is the presence of water in the indicator or in its connection with the cylinder." The connection, therefore, must be free of water when the diagram is taken. The indicator piping should be attached to a tee inserted between the cylinder and the drip valve. No diagrams should be taken until the cylinder is thoroughly warmed up and the engine is being suplied with dry steam. Then the diagram should be taken immediately after bleeding the cylinder of water.

Steam Saved by Cutting Off—How much less steam at 93-lb. pressure (gage) would be used by cutting off at 11 in. instead of following full stroke in a cylinder 16 in. long by 12 in. diameter?

R. S.

The cross-sectional area of a 12-in. diameter cylinder is 113.1 sq.in. Neglecting the space occupied by the piston and the volume is

$$113.1 \times 16 = 1809.6 \text{ cu.in.}$$

Cutting off at 11 in. of the stroke, the volume of steam would be

$$113.1 \times 11 = 1244.1 \text{ cu.in.}$$

The difference of volume of steam following full stroke and cutting off at 11 in. of the stroke, therefore, would be

$$1809.6 - 1244.1 = 565.5 \text{ cu.in.,}$$

or

$$\frac{565.5}{1728} = 0.327 \text{ cu.ft.}$$

Steam at 93 lb. per sq.in. boiler pressure is at

$$93 + 14.7 = 107.7 \text{ lb. absolute.}$$

From steam tables we obtain 0.2423 lb. as the weight of 1 cu.ft. of steam at 107.7 lb. absolute, so that the weight of steam used would be

$$0.2423 \times 0.327 \text{ cu.ft.} = 0.0792 \text{ lb.}$$

less per stroke when cutting off at 11 in.

Loss from Uncovered Steam Pipe—What would be the loss per year, due to radiation, per square foot of uncovered steam pipe, carrying steam at 120 lb. pressure, absolute, when the temperature of the air is 60 deg. F. and the coal has a heat value of 14,125 Bt.u. per lb. and costs $1.25 per ton?

W. A. R.

Each square foot of pipe surface would radiate about 2½ B.t.u. per hour per degree difference of temperature between the steam and air. Steam at 120 lb. absolute has a temperature of 341.3 deg. F. The air temperature being 60 deg., the difference is

$$341.3 - 60 = 281.3 \text{ deg. F.}$$

and the radiation per hour

$$281.3 \times 2.5 = 703.25 \text{ B.t.u.}$$

Per year then it would be

$$703.25 \times 24 \times 365 = 6{,}160{,}470 \text{ B.t.u.}$$

The coal required would depend upon the efficiency of the boiler. Assuming 70 per cent., for average fair conditions, and the heat utilized per pound of coal would be

$$14{,}125 \times 0.70 = 9887.5 \text{ B.t.u.}$$

Then the coal equivalent of the heat lost through the pipe is

$$\frac{6{,}160{,}470}{9887.5} = 623.056 \text{ lb.}$$

or

$$\frac{623.056}{2000} = 0.3115 \text{ tons}$$

and its cost

$$0.3115 \times \$1.25 = \$0.389 \text{ or } 38.9\text{c.}$$

per square foot.

Horsepower to Accelerate Hoisting Drum—If the face of a hoisting drum weighs 8000 lb., what will be the horsepower required to bring the speed of the rope winding on this drum from 0 to 1000 ft. per min. in 5 sec.? The diameter of the drum is 10 ft. and the face width 6 ft. Neglect the weight of the arms, hub and rope.

L. C. M.

The center of gravity of the cross-section of the rim may be assumed to have the same velocity as the cables, i.e., to have a final speed of 1000 ft. per min. or

$$\frac{1000}{60} = 16.667 \text{ ft. per sec.}$$

The kinetic energy or number of foot-pounds of energy in the rim when it has attained this velocity is given by the formula

$$K = \tfrac{1}{2} Mv^2$$

in which

$$M = \text{Mass} = \frac{\text{Weight}}{g}$$

and as

$$g = \text{Acceleration of gravity} = 32.16$$

$$\text{Weight} = 8000 \text{ lb.}$$

and

$$v = 16.667 \text{ ft. per sec.}$$

then

$$K = \tfrac{1}{2} \times \frac{8000}{32.16} \times 16.667 \times 16.667 = 34{,}550.82 \text{ ft.-lb.}$$

With uniform expenditure of power during 5 sec. there would be uniform acceleration and an expenditure of

$$\frac{34{,}550.82}{5} = 6910.16 \text{ ft.-lb. per sec.}$$

or

$$\frac{6910.16}{550} = 12.56 \text{ hp.}$$

in bringing the speed up to 1000 ft. per min.

ENGINEERS' STUDY COURSE

Making a Flue-Gas Analysis—Part V

Solution for CO_2

The solution for the first pipette, to absorb the CO_2, is caustic potash (chemical name, potassium hydrate) dissolved in the proportion of one pound of caustic to 2½ lb. (2½ pints) of water.

Perhaps the most convenient method is to mix up ½ lb. of the caustic at a time. A good way to do is to fill an ordinary one-quart milk bottle about five-eighths full of water and add half of the sticks in a one-pound package of caustic. If you have a pair of reasonably accurate small scales, you can weigh the bottle and then add the required 1¼ lb. of water, thus securing greater accuracy than guessing at five-eighths of a quart. A half pound of caustic will make a little more than enough solution for five loadings of the pipette. And one loading of the pipette is sufficient for about 325 analyses where the

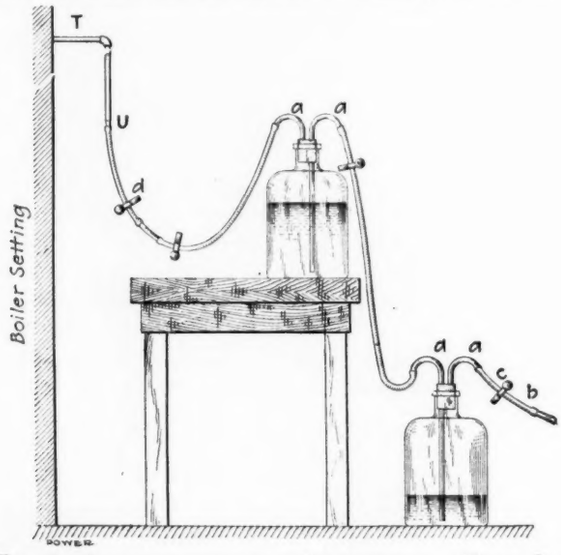


Fig. 5. Arrangement for Collecting a Time Gas Sample

percentage of CO_2 extracted each time is 12 per cent. Thus, one loading should last from three months to a year or more, depending on how often the apparatus is used. The bottle containing the unused part of the mixture should be carefully labeled, fitted with a cork or cover and stored away in a safe place. It is safest to handle the potash sticks with tongs rather than with the bare hands because while no harm will be done if both the sticks and your hands are dry, a disagreeable burn results if either happens to be moist. Use care in handling the solution when made up because a drop on the flesh will burn and a drop on clothing, shoes, etc., will eat a hole.

Solution for Oxygen

The solution for the second pipette, to absorb the oxygen, is potassium pyrogallate; made by mixing pyrogallic acid (which comes in the form of a powder) with a suitable quantity of the caustic-potash solution just described. As this solution absorbs oxygen it will quickly lose strength if exposed to the air; hence it must be sealed up as soon as possible.

A good way to mix the solution is to put 1 oz. of the pyrogallic acid into a quart bottle, pour in about a pint of the caustic solution and immediately seal the bottle air-tight.

After loading the pipette, place the gooseneck and rubber bag on the back leg as quickly as possible to exclude the air. One loading of the pipette will absorb about 200 c.c. of oxygen. Thus, if the average amount of oxygen in the flue gases analyzed is, say, 8 per cent., the solution would be good for about 25 analyses.

Solution for CO

The solution for the third pipette, to absorb the CO, is acid cuprous chloride. This can be most conveniently made as follows: Put enough copper oxide into a quart bottle to make a layer on the bottom ¼ in. thick. Put in ten or a dozen lengths of No. 10 gage copper wire, bare and clean, cut in lengths to reach from the top to the bottom of the bottle. Then, fill the bottle with hydrochloric acid (hydrochloric acid is simply equal parts water and muriatic acid). Seal the bottle air-tight and shake it occasionally to hasten the reaction. When the solution turns nearly colorless (after about 48 hr.) it is ready to use. After some of the solution has been taken out to load the pipette, immediately add more hydrochloric acid so as to keep the bottle full all the time. As the copper wire and copper oxide gradually disappear, add some of each from time to time so as to constantly keep about the usual amount in the bottle.

As this solution also deteriorates when exposed to the air, be sure to connect the rubber bag to the pipette as soon as it is loaded. One loading of the pipette will absorb about 100 c.c. of CO; hence it would be good for about 100 analyses where the amount of CO in the flue gas averaged 1 per cent.

When any of the solutions begin to show signs of weakness they should immediately be renewed regardless of the length of time they have been in use.

Taking the Sample

The best place from which to take the sample of flue gas is from the last pass, if the boiler is a water-tube, or from the connection between boiler and breeching if a fire-tube. Cut a length of ½-in. pipe *T*, Fig. 5, long enough to extend half way across the gas passage and project out about 6 in. at one side. Fit an elbow and vertical connection to this as shown. The pipe *T* may be inserted either through a drilled hole or through some existing opening. In either case, stop up the hole or opening around the pipe with waste or plastic asbestos so as to prevent the danger of air leaking in and spoiling the sample. Be sure that the piping is made up air-tight.

Draw the end U down so that ¼-in. rubber tubing can be pushed over it.

If instantaneous flue-gas readings are wanted, connect the Orsat and the end U by a length of rubber tubing and proceed to draw in the sample as before directed.

If a sample representing a certain period of operation is desired, an arrangement, such as shown in Fig. 5, may be used. Obtain two large bottles, such as those in which spring water is sold, and fit them with rubber corks, each perforated for two glass tubes. These corks can be secured from the dealer who sells you the flue-gas apparatus. Then, fit each bottle with one long glass tube, and one short one in the manner shown. If the top of each glass tube is heated and bent over, as shown at a, the rubber tubing is not so likely to kink up and stop the flow of water.

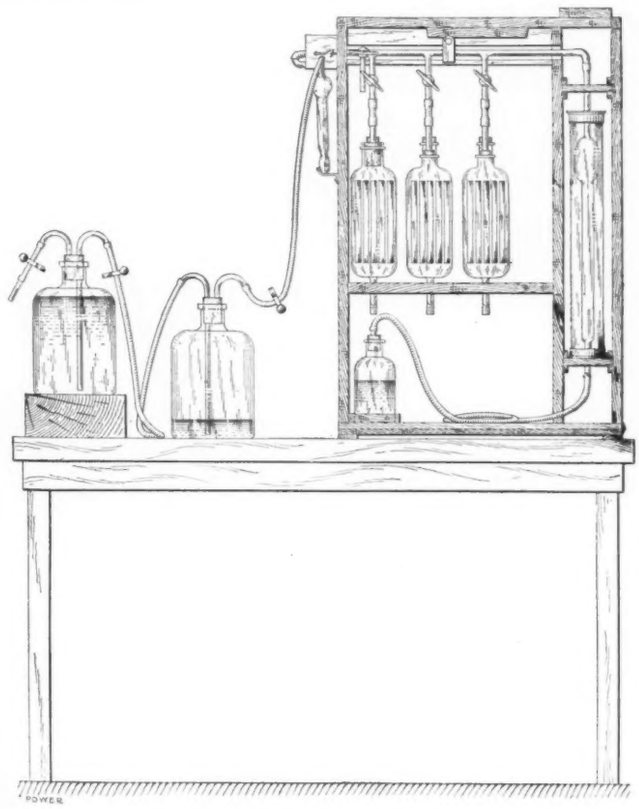


FIG. 6. ARRANGEMENT OF SAMPLING BOTTLES AND APPARATUS

Fill one bottle full and the other about one-eighth full of water. Connect the long tube of each bottle with a length of rubber tubing about 6 ft. long; connect each short tube with a length of rubber tubing about 12 to 18 in. long and in the end of these short lengths insert a glass-tube nipple, 4 to 6 in. long, as shown.

Arrange the bottles one above the other, as shown in Fig. 5, and let water siphon into the lower bottle until it is full and water begins to run out at b. Then, set pinch cock c and reverse the bottles, connecting b with the tubing d. Before doing this, however, apply the small hand pump, which comes with the flue-gas apparatus, to the end of the tubing d and expel all the air in the piping; then, set a pinch cock on d as close to the lower end as possible. If these directions are followed closely, very little or no air will get into the system to make the sample unfair.

Now, release all pinch cocks and allow the water to siphon from the upper to the lower bottle. This causes a vacuum in the upper bottle which draws in the gas from the boiler.

By heating the end of one of the long glass tubes and drawing it down to a finer opening, a longer time will be required to siphon the water over and hence to fill the upper bottle with gas. If, for instance, an 8-hr. sample is desired, a little experimenting with the size of opening in the glass tube will result in getting the time of water flow about correct. Of course, as it is not necessary to have more than perhaps a quarter of a bottle full of gas, the length of time required for the water to siphon over does not matter much, provided it is longer than the length of the test desired.

When the desired gas sample has been drawn into the upper bottle, set all pinch cocks and arrange the bottles, as shown in Fig. 6, the one full of water slightly higher than the other. With this arrangement the gas is under a slight pressure and if the system is accidentally opened, gas will escape, but no air will leak in to spoil the sample. Connect the gas bottle with the flue-gas apparatus, as shown, and proceed with the analysis as explained in previous paragraphs.

As water absorbs CO_2, the water in the collecting bottles should be saturated with gas before samples for testing are collected. This can be done by drawing some gas first into one bottle, then into the other and allowing it to stand for some time, shaking the bottles now and then to induce complete saturation.

CARE OF APPARATUS

In course of time the rubber tubing and connections used with the Orsat will become hard and crack, when they will need renewing.

The caustic will affect the glass pipettes. Hence, if the apparatus is not to be used for some length of time, it is well to empty the apparatus before storing it away.

The glass stop cocks must be kept clean or they will not remain air-tight. Also, if they are not lubricated frequently, they may become stuck and cause trouble. A good lubricant to use is vaseline. This point should be attended to frequently if trouble is to be avoided.

16 Lb. per Hp.-Hr. Noncondensing

On Apr. 9, 1913, F. W. Dean, of Boston, conducted a trial of one hour's duration on a Lentz simple horizontal noncondensing engine erected at the plant of the Erie City Iron Works for the purpose of testing with superheated steam. The engine drove an electric generator by means of a belt, and the current was absorbed by a water rheostat.

The exhaust steam was condensed at atmospheric pressure by passing it through four Erie feed-water heaters, through the coils of which cold water was run. This was done for the purpose of weighing the exhaust in barrels resting upon platform scales. The steam was so perfectly condensed that only a trifling quantity of vapor escaped, so small that it would not affect the result by a measurable quantity. It was found by examination that no water leaked into the exhaust from the condensing supply.

The revolutions of the engine were determined by a counter worked from the valve-gear. The indicator reducing motion was practically correct. The temperature

and pressure of the steam were taken from the steam chest of the cylinder, the former by a refined stem graduated thermometer and the latter by a test gage. The scales were carefully tested by means of standard weights and made correct.

The indicator diagrams were taken every 10 min. with a Crosby inside-spring indicator, and all other readings at the same intervals, except the water records. There were two weighing barrels and each was allowed to fill until the scale beam tipped, the other barrel being meanwhile emptied.

The test lasted one hour only, and the data were complete for that hour. It would have been longer if the generator had not begun to burn out toward the end of the second hour. Concerning the accuracy of a test of such short duration, as the engine was run for some time before the test began, it was properly heated, and the weight of condensed steam can be determined with the greatest accuracy in the manner described.

After the test was over the cylinder head was removed and the diameter of the cylinder and the stroke of the piston measured, with the following results: Diameter of cylinder, 19.167 in.; stroke of piston, 21 in.; diameter of piston rod, 4 in. The pressure, temperature and superheat of the steam were as follows:

Time, p.m.	Press., lb.	Temp., deg. F.	Superheat, deg. F.
1 : 50	135	420	61
2 : 00	133	444	87
2 : 10	133	460	103
2 : 20	134	456	98
2 : 30	133	456	99
2 : 40	131	456	100
2 : 50	132	458	101
Averages	133	450	92.7

The average temperature of the exhaust steam was 210.5 deg. F. The barometer was 29.59 in. The exhaust pressure absolute was about 16.2 lb., the temperature of which, if saturated, would be about 217 deg. As the temperature of the exhaust was below this it follows that no superheat was left in the steam when it entered the exhaust pipe.

RESULTS OF TEST

Spring 60

Average r.p.m.	Average Areas Head Card	Crank Card	Average Length Both Cards	Horsepower Head	Crank
206.18	2.464 sq.in.	2.448 sq.in.	3.66 in.	127.4	121.1

Total average horsepower..... 248.5
Steam used in hour, lb..... 4008
Steam used per hp.-hr, lb..... 16.13

During the portion of the second hour while the test lasted the superheat was about 119 deg., and the economy was about 16.03 lb. Assuming an initial pressure of 148 lb. abs., 92.7 deg. F. superheat, and exhaust at 217 deg., the Rankine efficiency at 16.13 lb. would be 91.5 per cent., and at 16.03 lb., and with the 119 deg. superheat, a little over 90 per cent. These results are remarkable and perhaps the best that have ever been obtained from a simple noncondensing engine. According to Mr. Dean the engine ran perfectly and the valve-gear left nothing to be desired.

❖

The Lighting Rates Committee of the board of supervisors of San Francisco has recommended that the ordinance establishing rates for electric current for the next year shall embody a reduction in the rate for lighting in residences and apartment houses from eight cents a kilowatt-hour to six cents a kilowatt-hour. It is estimated that this would mean a reduction of $250,000 in revenue to electric companies of the city based on the business of the present year. The Committee also recommends a reduction in the minimum charge for electric current from $1 to 75 cents a month. In addition the committee has reported that the present gas rate of 75 cents a thousand cubic feet should remain in force.—"Electrical Review & Western Electrician."

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

How would you like a big high one just this very minute? You know, when the light is flashing out all those rays of beautiful amber tint, and the creamy foam is billowed lovingly on the crest of the glass, and tiny diamond-like beads cling to its sides, and your shirt collar is thrown back, and your old carpet slippers dangle on one toe, and the willow rocker just fits, and the pipe draws right and the thermometer is climbing up in the nineties, and—

Say, son, there's nothing more satisfying to a 200-hp. thirst than a glass of good ice-cooled sarsaparilla—unless it's what you thought we meant when we first started this.

❖

Seats in the New York Stock Exchange have shrunk over sixty millions, remarks "Collier's Weekly," and the common people have got Wall Street's goat. Give a sturdy gentleman goat half a chance, and most any seat will shrink; he plays the game where all the butting in is kept to himself. Everything seems to be shrinking these days, even the weather. Why not seats?

❖

A Welsh coal king's daughter has been arrested as a militant firebug. Looks like girlie got the wrong slant on what constitutes a proper product of combustion.

❖

Wilbur Smith, over to Alton, Ill., tips us off to a St. Louis furniture concern's method of mingling education with business. "For $1 down and $1 a month, a man can buy a bookcase filled with choice books; the books are thrown in." Wilbur says this scheme may help every engineer to a library without the bother of selection. Says he: "Who can select it better than his furniture man? Just send him the color of your carpet and the wallpaper, and he does the rest."

❖

In an endeavor to help "the poor begrimed engineer" in his struggle with the examiners, John S. Myers gives this list of Q's and A's. They may cheer us up, whatever else they might do:

Q. Of what use is a steam dome on a boiler? A. To catch the steam.

Q. Of what use is a mud drum on a boiler? A. To catch the mud. (Don't mix my answers to the last two questions.)

Q. What precautions should the engineer take when necessary to stop, with heavy fires? A. If he was firing with natural gas the proper thing would be to shut off the gas, if firing with the usual fuels he should take the usual precautions.

Q. When should a boiler be blown out? A. When you don't need the steam for other purposes.

Q. When laying up a boiler, what should be done? A. "Laying up" is against the laws of gravitation. Don't try it; it can't be did.

Q. How do you find the horsepower of an engine? A. It is usually found about as specified and guaranteed, it is sometimes marked on the nameplate, the builders will usually answer a polite inquiry or, if you hanker after personal investigation, use an indicator, a planimeter and a slide rule and figure it out. This is the scientific P L A N. If not satisfied then, see how big a load it will pull.

Q. How much wood equals one ton of soft coal for steam purposes? A. That depends upon the wood and the fireman.

Q. What is vacuum? A. Nothing much, I don't guess.

Q. What is meant by triple-expansion engine? A. Something like a three bagger, only different. The batter goes three-quarter ways round on one hit while the steam gets three hits and makes three home runs.

Q. Is there any danger of a well fitted and tightly keyed flywheel coming loose? A. Lord protect us if there is! There's enough danger from the other variety.

Q. Where is the dead center of an engine? The point of stroke where the oiler cusses like a pirate when the engine stops there.

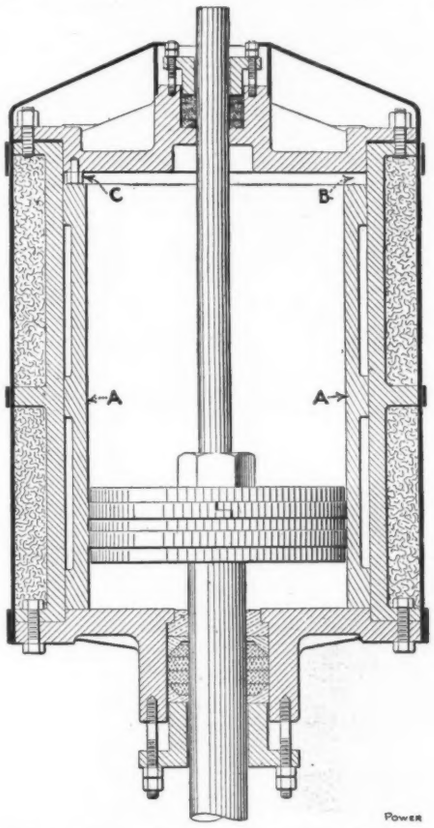
Q. Can you explain the term clearance? A. I can, but I've run out of paper; besides, you only asked me could I? Believe me! I can do it. If you really want to know what clearance is, come around to the power house some day and I'll tell you.

Loose Liner in Cylinder Causes Severe Knock

By Herbert E. Collins

While serving as refrigerating engineer aboard the Ward Line S.S. "Mexico," an interesting breakdown of one of the main engines occurred. The ship was propelled by two triple-expansion engines and the 28-in. diameter high-pressure cylinder of the port engine was the seat of the trouble. The cylinder was constructed, as shown in the sketch, with a liner *A*, which formed the wall of the cylinder. A tail rod extended through a stuffing-box in the cylinder head.

An elusive knock developed in this cylinder which was thought to be caused by a shoulder on the tail rod at the



Engine Cylinder, Showing Liner That Worked Loose

end of its downward travel. This shoulder was dressed down with an oil stone, but as soon as the engine became warm on leaving port, the knock returned. Many possible explanations as to its cause were offered.

On the voyage in question, on the morning of the third day out of New York, the knock had increased until it sounded like the blows of a trip hammer and became louder and louder. The engineer on watch was standing near the throttle lever when suddenly the sound ceased altogether and comparative silence ensued for a few revolutions. This startled the engineer into releasing the clamp on the throttle lever and he was still standing with the lever in his hand when the knock returned with a crash that could be heard in every part of the ship. The engine was immediately shut down, and we proceeded with the starboard engine, while the high-pressure cylinder head of the port engine was removed, and the cause of the trouble became apparent. The lining of the cylinder had worked loose, it having been merely forced into place and not secured in any way. It was this liner gradually becoming looser and looser and being raised by the piston on its upward stroke and then slammed down against the cylinder bottom which caused the increasing knock. There was a space of 5/8 in. between the top of the liner and the bottom of the counter bore in the cylinder head, as shown at *B*. This gradual loosening went on until the liner became adrift altogether and raising with the piston it jammed at the top of its travel for a few revolutions, causing the cessation of the knock, after which it proceeded to move with the piston once more, and to slam alternately against the cylinder head and the bottom of the cylinder.

The first assistant engineer made the repair in a very simple and effective manner. Four holes were drilled in the plug of the cylinder head near its circumference and tapped for 3/4-in. bolts. In the meantime bolts were threaded clear to their heads and when they were screwed into the holes the depth of their heads was found to equal the space *B*, as shown at *C*, and upon the head being replaced, and the engine started, the repair was found to be satisfactory. Although the liner was firmly secured in its place on our arrival at New York, it was not at all necessary, as the temporary repair would have done as a permanent one.

Power Costs at Worcester Consolidated Plant

In connection with a report on operating conditions upon the Worcester Consolidated Street Railway, data are presented on the cost of power production at the company's generating plant at Millbury. This plant, states the *Electric Railway Journal*, is the most modern street-railway generating station in central Massachusetts and at present contains four Edgeworth 820-hp. boilers with Murphy stokers, two 300-kw., 600-volt, direct-current generators driven by horizontal compound-condensing engines, and a 5000-kw. steam-turbo unit, supplying the Worcester system through step-up transformers and two 13,000-volt lines carried on steel towers to a 3000-kw. substation at Madison Square, Worcester, 6.5 miles distant. The operating steam pressure is 185 lb. The cost of operation taken from the station log on Feb. 18, 1913, was as follows:

Labor:	
Two machinists	$5.00
Three engineers	14.30
Three laborers	6.00
Three helpers	12.00
Six firemen	12.00
Three water tenders	6.75
Three coal laborers	5.25
Total labor cost	$53.80
Total cost of fuel and supplies	337.72
Total cost of manufacture	$391.52
Total cost of manufacture per kw.-hr.	0.67
Kw.-hr. output	57,448

It is proposed that the water brought to Madrid, Spain, by the Isabel II Canal be utilized for the production of electricity. It is estimated that 3000 hp. can be developed and sold, and the receipts used to reduce the price of water to the ultimate consumer. It is thought that five or six years will be required to complete the Puenteviejas waterworks. When this is finished the two plants will have a storage capacity of 2,155,000,000 cu.ft. and a minimum of 9000 hp. can be developed.

Lanz Counterflow Superheater

By Dr. Alfred Gradenwitz

The new Lanz counterflow superheater, with bypass flue, has been designed to utilize the heat in the flue gases as much as possible by using the counterflow principle. Closed loops are avoided in arranging the serpentines, as the superheater coils are called, thus avoiding water pockets, and at the same time not interfering with the ready access to the smoke tubes and tightening screws of the tube system. Means are provided for quickly mounting and dismounting the superheater, throwing

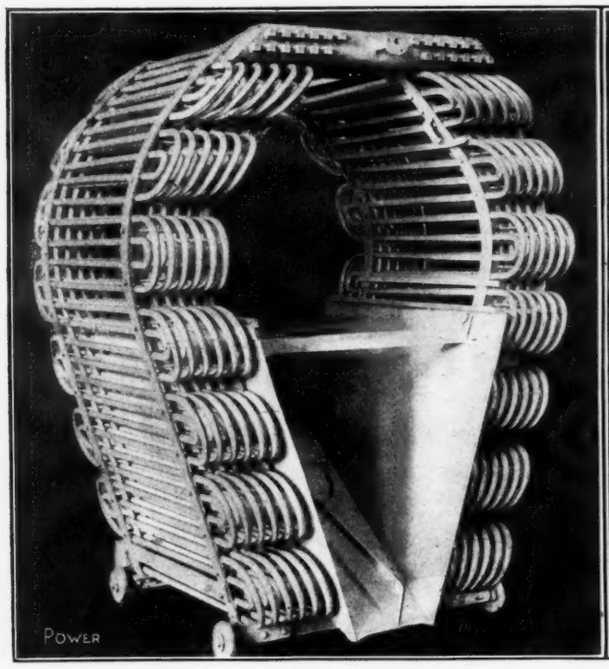


Fig. 1. Horseshoe Superheater for Large-Size Portable Steam Engine

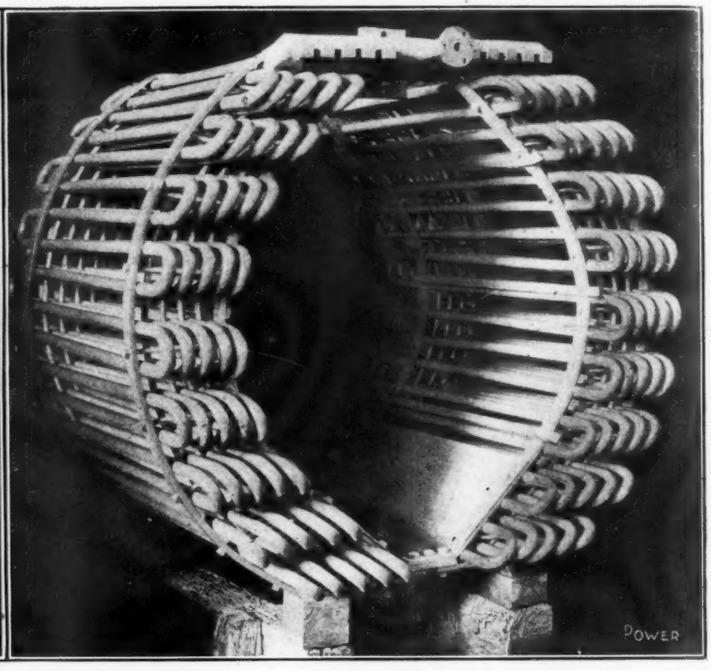


Fig. 2. Round Superheater for Small- or Medium-Size Portable Steam Engine

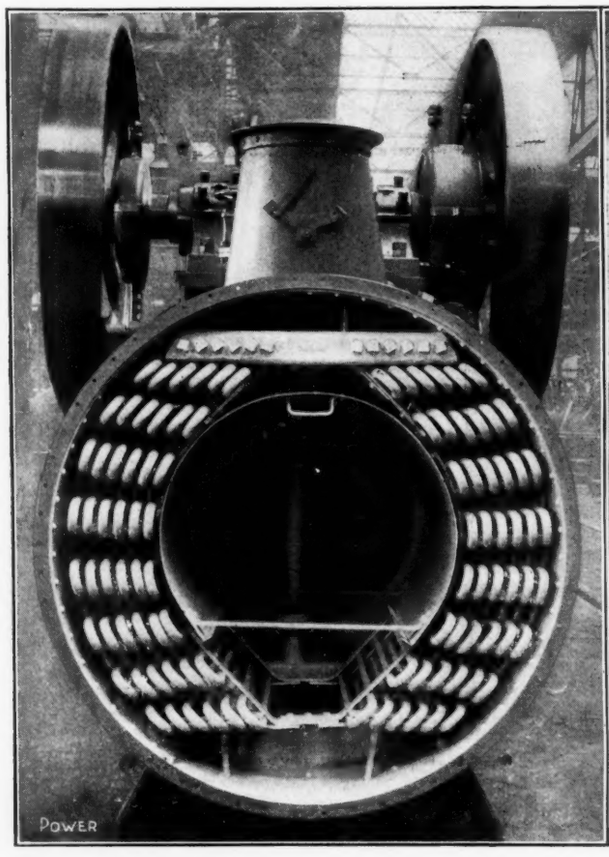


Fig. 3. Round Type of Superheater in Position

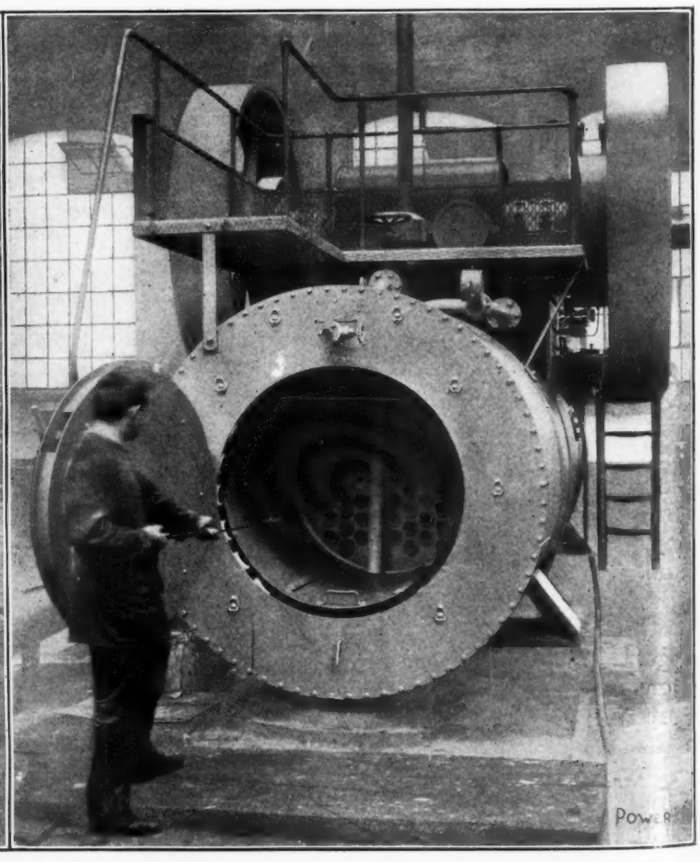


Fig. 4. Horseshoe Type of Superheater in Position

it out of operation whenever desired, and controlling at will the degree of superheat.

This superheater comprises a double-section annular basket of parallel horizontal serpentines which terminate at the top and bottom in a wrought-iron steam-collector tube. A removable drum locks the superheater against the interior of the smoke box, and compels the furnace gases to follow a given course.

In the case of portable steam engines, having sheet-metal chimneys fitted on the smoke box, the flue gases from the boiler tubes go in a downward direction, and after dividing to the left and right, encompass the superheater serpentines in an upward direction, and escape to the stack. The steam from the boiler enters the top of the superheater, and traversing the serpentines in a downward direction, passes as superheated steam from the lower collector tube into the high-pressure cylinder. The steam and hot gases are thus directed in a counterflow, which insures high thermal efficiency.

In medium- and large-sized portable steam engines, the flue gases, after leaving the superheater, are led downward into a smoke channel and thence to the chimney. In this case the position of the drum is inverted and the smoke gases are at first directed upward, so as to flow round the superheater serpentines in a downward direction. The steam enters the superheater from the bottom, and passes from the top to the engine, so that the counterflow principle is maintained.

The superheaters are made in two types of high-grade drawn-steel tubes. Small- and medium-sized portable steam engines are provided with round superheaters, Fig. 1, fitted into the circular smoke box. In the case of large-size steam engines a horseshoe-shaped type of superheater, Fig. 2, is used, which at its lower end penetrates into a masonry extension of the smoke box, resting on rollers and rails. The drum in this case is made of several sections, thus facilitating its removal. Figs. 3 and 4 illustrate the round and horseshoe types of superheaters in position.

The most striking advantage of the superheater is the patented arrangement of the superheater tubes, which rise continually in horizontal serpentines, without forming water pockets, thus eliminating any risk of water-hammers. The precipitated water of the superheater flows by gravity to the lower steam-collector tube, to be discharged through a cock.

In the case of large-size superheaters the lower part is specially designed as a collector for the flue dust which, sliding on an inclined plane down to a discharge door, is readily discharged during operation. This inclined plane comprises a valve actuated from outside, by means of which part or all of the flue gases can be directed immediately into the chimney or the smoke channel, thus allowing the superheater during operation to be wholly or partly cut out, and the degree of superheat controlled at will.

The superheater is cleaned by a steam-jet blower, the soot being discharged from the bottom through the discharge door, or in the case of the round type of superheater, through a door in the smoke-box bottom.

The superheater is easily removed, after loosening two flanges and the smoke-box bottom, by withdrawing it endwise through the front of the smoke-box and all parts are thus made readily accessible.

Welding Locomotive Boiler Tubes

At the annual convention of the American Railway Master Mechanics' Association, held in Atlantic City on June 11 to 13, the committee on Designs, Construction and Inspection of Locomotive Boilers presented an interesting report dealing mostly with the maintenance of locomotive boilers. The committee had been instructed to investigate the results obtained by electric welding and it also included results obtained by the oxyacetylene process. Extracts from the report follow:

A road using the oxyacetylene process welded in a number of small tubes and omitted copper ferrules, as with them they could not make satisfactory welds. The tube sheet was prepared, as shown in Fig. 1. View *A* shows a tube projecting through the sheet far enough so that when finished the beads will be the same size as when beaded in the regular manner. View *B* shows the tube after being welded. The same road also experimented with flues welded, as shown in Fig. 2. The tubes were allowed to extend through the sheet $\frac{3}{16}$ in., as at *A*, and were prossered and then welded as at *B*, after which a

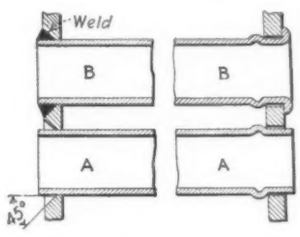


Fig. 1

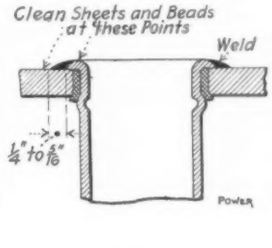


Fig. 3

Fig. 2

beading tool was used to smooth up the bead. These flues have been in service only a short time but so far have been satisfactory.

Another road using the oxyacetylene process for welding believes that the copper ferrules are not necessary. The flue sheet is prepared as follows: The old flue having been removed, the first operation is to draw the centers of the back and front flue sheets toward each other. The center of the back sheet is drawn forward about 1¾ in. and the front sheet about 1½ in. This is accomplished by applying 11 stay-rods distributed in a circle about 2½ ft. in diameter, one of the rods being located in the center. While these rods are under tension the back flue sheet is annealed around the edges by an oil torch. The rods are then removed and there is a permanent dish in the back sheet of about 1¼ in., and in the front sheet of 1⅛ in. The holes are then countersunk on the fire side to a depth of ¼ in. The flues are set in place projecting ⅛ in. beyond the flue sheet, and are then rolled and welded.

One road had considerable difficulty with the large superheater tubes in the back flue sheet. One engine which had a flue mileage of 75,000 was brought to the shop and the large flues welded electrically. Nothing was done to the flues or beads except to clean them before welding. These flues were originally provided with copper ferrules. Metal was built around the head, as shown in Fig. 3, and the weld was made from the edge of the bead to the sheet. The reason that the ferrules and flues were prossered and rolled was that the welding was more in the nature of an experiment and proved so successful that the method was continued. The engine was placed

in service and has made 14,000 miles without giving any flue trouble.

From the reports received from different roads it was apparent that considerable difficulty is experienced in welding flues by the oxyacetylene process, while with the electric process satisfactory results are obtained. One road especially tried out both methods and has adopted the electric process for standard practice.

From cost figures given in the report it was shown that the cost of welding flues electrically is cheaper than by the oxyacetylene process. The cost per flue is increased if the weld is made after the flues are set in the regular manner, but the maintenance cost is almost entirely eliminated and the engines can be kept in service a greater length of time. Present indications are that the flues can be run the three-year limit without removal.

Bristol's Float-Type Recording Differential-Pressure Gage

This new float-type differential recorder, Fig. 1, has been tested out under practical operating conditions. It was invented and developed by Prof. W. H. Bristol and is manufactured by the Bristol Co., Waterbury, Conn., to meet requirements for which the spring-pressure types of differential recorders are not suitable, that is for very low ranges of differential pressure in air, gases, liquids or steam, for applications where the static and differential pressures fluctuate rapidly, and also to satisfy the demand for instruments to record the rate of flow or volume directly on charts having uniform graduations in units of flow or volume.

The construction and principle of operation of the instrument will be understood by referring to the sectional diagram, Fig.2. There are two pressure chambers *A* and

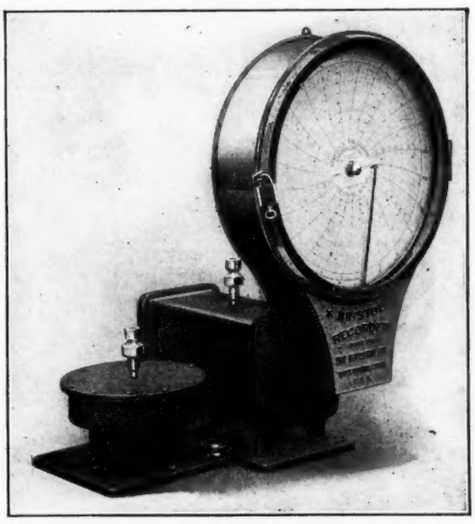


FIG. 1. FLOAT-TYPE RECORDING DIFFERENTIAL-PRESSURE GAGE

B intercommunicating through the connection *C*. A cylindrical float *D* is located in the pressure casing *A*, and is connected by arms to the shaft *F*, which extends through the casing, and to which the recording arm *G* is directly connected.

Connection is made by the pipes *H* and *I* between the pressure chamber *A* and *B* and the two pressures the difference of which is to be recorded. Mercury or water is employed in the pressure chambers, according to whether the differential range to be recorded is high or low. When the higher pressure is applied to the chamber *B* through the pipe *I*, the level of the liquid in this chamber is lowered and that in the float chamber is raised, carrying the float and the attached recorder arm with it, thus making a record on a circular chart as it is revolved by a special clock at the desired speed.

By making the cross-sections of the pressure chamber *B*

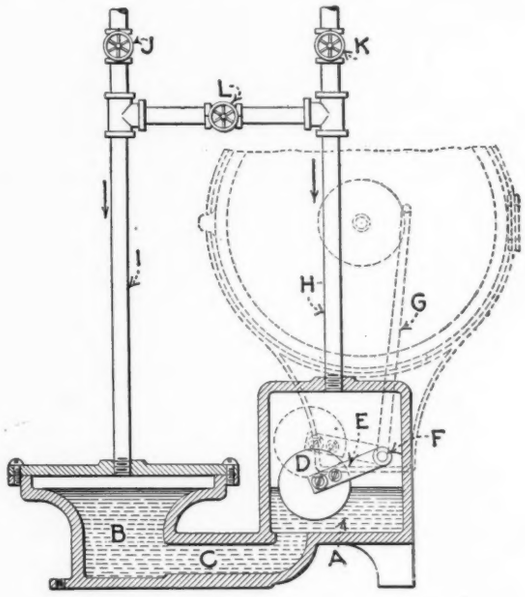


FIG. 2. SECTION THROUGH GAGE

of certain proportions, it is possible to produce a scale whose graduations are uniform for equal increments of flow or volume. The Bristol-Durand radii-averaging instrument can, therefore, be used to obtain a total flow or volume from the chart record of this instrument for a period of 24 hr.

As these gages will operate on extremely low differential ranges they are particularly well adapted for use in connection with Pitot tubes for recording volumes of liquids, air or gases.

The chart used is graduated in thousands of cubic feet of gas per hour, the range being from 0 to 500,000 cu.ft. per hr. The working part of the chart above 150,000 is provided with uniform volume graduations.

This instrument may be used to record the head of water in tanks under varying pressure, as, for instance, height of water in steam boilers and heaters. Another special application is that of recording the flow of water through a notch or over a weir, even though the liquid is under pressure or a vacuum.

In the United States steam-railroad electrification is now in operation or in course of construction on 1645.3 miles of single track, and about 1250 miles in addition have been approved for electrification. The first such work was done by the Baltimore & Ohio at Baltimore in 1895. The greatest mileage of the 1645.3 miles owned by any one railroad is that of the New York, New Haven & Hartford, 594.8 miles, of which 104.4 miles is or will be operated by low-voltage direct current, and 490.4 by high-voltage single-phase. The New York Central and the Pennsylvania systems each contribute about 400 miles to the total, using the low-voltage direct-current system. The Butte, Anaconda & Pacific and the Southern Pacific each have about 90 miles under high-voltage direct current.

Pennsylvania N. A. S. E. Convention

The 14th annual convention of the Pennsylvania State Association of the National Association of Stationary Engineers opened at Chester, Penn., on June 27, in the main auditorium of the Young Men's Christian Association building. It was about 11 o'clock when the session was called to order by N. D. Orms, the president, of Johnstown. About 50 delegates were present.

The address of welcome was made by Mayor William Ward, Jr., who assured the visitors that Chester extended the glad hand of hospitality to them and felt honored by their presence. He expressed the hope that they would fully enjoy themselves during their two days' stay in the oldest town in the Keystone State.

The response was made by Samuel B. Forse, treasurer of the state association. Remarks were also made by Albert N. Monsinger, the secretary, and A. C. Cotton, the vice-president.

A musical and literary entertainment was given in the auditorium under the auspices of the local reception committee, composed of James D. Rostron, chairman; Fred D. James, secretary; Ernest Uff, treasurer; Charles C. Morton, Edward T. Ferguson, Thomas J. McAllister, Alfred Horn and Thomas Hutchinson. The program included recitations, vocal and instrumental selections and brief addresses.

The supply committee was composed of Frank Martin, Fred L. Jahn, W. J. Brice, Charles Hopper, Harry Souder and Harry N. Winner, all of Philadelphia.

The ladies were taken on trips throughout the city and vicinity in automobiles, starting from the Y. M. C. A. building.

Friday morning the business session began at 9:30 o'clock. In the afternoon the delegates and the ladies were the guests of the West End Boat Club, at the organization's handsome headquarters at the foot of Central Ave.

Among the exhibitors were:

Cyrus Borgner Co.
United States Graphite Co.
William C. Robinson & Son
Greene, Tweed & Co.
Philadelphia Grease Mfg. Co.
Jenkins Bros.
John R. Livezey
Watson & McDaniel Co.
"Power"
Dearborn Chemical Co.
Lunkenheimer Co.
Ford & Kendig Co.
The Garlock Packing Co.
Harrison Safety Boiler Works
Keystone Lubricating Co.
Warren Webster & Co.
Westinghouse Electric & Manufacturing Co.
The Wickes Boiler Co.
Thomas C. Warley & Co.
Under Feed Stoker Co. of America
N. Y. & N. J. Lubricant Co.
Local Steam Packing Co.
Lagonda Manufacturing Co.
Anchor Packing Co.
H. B. Underwood & Co.
Dixon Crucible Co.
Peerless Rubber Co.
"National Engineer"
H. W. Johns-Manville Co.
Robert Wetherill & Co.
Berry Engineering Co.
Harper Packing Co.
Rooksby Engineering Co.
Economy Iron Works
Benjamin F. Shaw & Co.
Delaware Electric & Supply Co.
R. & J. Dick, Ltd.
Joseph F. Schiller.

Ohio N. A. S. E. Convention

The Ohio State Association of the National Association of Stationary Engineers held its sixteenth annual convention in Toledo on June 11, 12 and 13. The exhibits and business sessions were held in Memorial Hall while the hotel headquarters were at the Boody House.

The first session was called to order on Wednesday morning by F. E. Smalley, chairman of the local committee. The Rev. E. B. Allen pronounced the invocation.

Charles H. Wirmel, chief examiner of stationary engineers for Ohio, and representing Governor Cox, spoke principally of the things accomplished last year in the stationary engineering field in Ohio. The boiler-inspection laws, already strong, were made even stronger by incorporating in them some important rules of the department. The history and condition of every one of the 20,000 registered boilers were carefully recorded so that complete data exist of a boiler's employment practically from the time it leaves the shop until it is scrapped. There are now 17,000 licensed engineers in the state and last year over 60 convictions for violation of the license laws were secured.

There was also established a department of engineering research at the state university which is available for the solution of steam-engineering problems as well as others.

Commissioner of Police Mooney represented Mayor Brand Whitlock, who was unavoidably absent. National President John F. McGrath gave a short outline of the history and work of the association, dwelling particularly upon the work of the past year.

Mr. Biggers, secretary of the Toledo Commercial Club, welcomed the delegates on behalf of the business men of the city. National Secretary Fred Raven, in the course of his remarks, told of the great need of adequate license laws in Illinois—laws similar to those of Ohio and Massachusetts. He also mentioned the need of advertising the N. A. S. E., its aims and its work, not only among the engineering but among all classes so that the good purposes for which it is working may be the more speedily accomplished.

At the formal opening of the mechanical exhibit, E. J. Jacques spoke briefly in place of President Osborne, of the Central States Exhibitors, who was detained elsewhere.

Among the numerous matters acted upon was the adoption of a resolution to fix the date of the first day of the annual state convention for the second Wednesday in June. Another resolution recommended that provision be made to examine the district examiners of stationary engineers by a board of practical and experienced engineers to determine their fitness and proficiency. This resolution and one recommending that the existing fee of $2 for renewing a license be abolished were referred to the legislative committee.

At the final business session the following officers were elected: President, J. E. Radigan; vice-president. W. D. Spangler; secretary, D. E. Kennedy; treasurer, John Wirmel. The new officers were installed by National Secretary Fred Raven assisted by E. J. Jacques. Akron was selected as the place for the next annual state convention.

This convention was unusual in that no educational features were provided. At most state conventions at least two or three papers or lectures are given. The explanation may lie in the fact that the Ohio state organization is a particularly large one and, consequently, the volume of association business, etc., to be accomplished is very great. The mechanical exhibit, which was especially large and interesting, was well attendad by delegates and visitors. Over 50 booths were occupied by the members of the Central States Exhibitors Association.

The entertainment features were well planned. On Wednesday afternoon the ladies enjoyed an auto ride about the city. On both Wednesday and Thursday evening an informal musical entertainment was given in the exhibit hall. On Thursday afternoon a trolley ride around the beautiful Maumee Valley belt was enjoyed by both delegates and guests; enroute, stops for inspection were made at the filtration plant and several industrial works. The big feature of the entertainment program, however, was an excursion on Lake Erie on Friday afternoon and evening. The large modern lake steamer "State of New York" left Toledo at 1:30 p.m., with nearly 1000 delegates and guests aboard and returned at 9:30.

The state organization of the Ladies Auxiliary held a business session on Thursday and consummated plans for organizing "Winship" Auxiliary No. 10 of Ohio. National President Olive Heckler telegraphed permission to perform the instituting ceremonies during the Friday excursion. State Deputy Josephine Lerch, to whose efforts the creation of the auxiliary is largely due, performed the instituting ritual, assisted by Past National President Florence Delaney and National Secretary Fred Raven.

The following officers were elected: Past president, Mrs. L. Long, president, Mrs. Thomas Winship, in honor of whose husband, "Uncle" Tom Winship, the organization was named; vice-president, Mrs. Mable Smalley; recording secretary, Mrs. F. M. Moran; financial secretary, Mrs. Clara Moore; treasurer, Mrs Mabel Chamberlin; conductor, Mrs. May Jacob; chaplain, Mrs. Doll; herald, Mrs. Betts; doorkeeper, Mrs. Brown.

This is the second auxiliary to be instituted by Sister Lerch. It is the largest in Ohio and said to be the second largest in the United States, 77 charter members being enrolled.

Connecticut State N. A. S. E. Convention

The 18th annual convention of the Connecticut State Association of the National Association of Stationary Engineers was held in Meriden, Conn., June 26, 27 and 28, with headquarters at the Winthrop Hotel.

The auditorium of the city hall was tastefully decorated and arranged in booths by the local committee for the supplymen's exhibit of power-plant machinery and supplies, 50 booths being occupied for this purpose. The several sessions of the delegates were held on the upper flow of the auditorium. There were 90 delegates in attendance.

The convention was formally opened at 12 o'clock noon, on Thursday, with a short address by Frank Hastings, chairman of the local committee, who introduced Mayor Daniel J. Donovan. Mr. Donovan gave the delegates and visitors a hearty welcome to the city, and hoped their stay would prove a pleasure and a profit. National Vice-President James R. Coe

responded for the engineers, and the ceremonies closed with a short address by State President Thomas J. Phillips.

The principal feature of entertainment was the Dutch supper at Mefferts Terrace Garden. Music, speeches and songs helped to make the occasion merry.

At the closing session of the engineers the following state officers were elected: President, Bernard C. Reynolds, New Haven; vice-president, Charles M. Dowd, Bridgeport; secretary-treasurer, John Galvin, Meriden; conductor, James J. McGee, Hartford; doorkeeper, James A. Austin, Norwich; state deputy, Richard J. Greene. Thomas J. Phillips, Warren H. Goodrich and Charles H. Ostrander were chosen as trustees.

The officers elected by the Connecticut State Supplymen's Association were: Fred Upson, president; Nelson D. Merwin, vice-president; Harry N. Glynne, secretary-treasurer.

The 1914 convention will be held in Bridgeport.

EXHIBITORS

Eagle Oil & Supply Co.
Pratt & Cady Co.
Peerless Rubber Mfg. Co.
The Garlock Packing Co.
A. W. Harris Oil Co.
Albany Lubricating Co.
Hartford Mill Supply Co.
The Taylor-Flagg Co.
The Lunkenheimer Co.
Nightingale & Childs Co.
Philadelphia Grease Co.
McClave-Brooks Co.
C. S. Mersick & Co.
Keystone Lubricating Co.
Botfield Furnace Specialties Co.
V. D. Anderson Co.
The Welding Co.
Dearborn Chemical Co.
Jenkins Bros.
McLeod & Henry Co.
Ashcroft Mfg. Co.
Consolidated Pop Safety Valve Co.
Hancock Inspirator Co.
Hayden & Derby Mfg. Co.
American Metal Hose Co.
H. W. Johns-Manville Co.
Evans Mill Supply Co.
Roto Co.
"Power"
Durabla Mfg. Co.
Ashton Valve Co.
Walter G. Ruggles Co.
Greene, Tweed & Co.
Economy Lubricating Co.
Travelers Indemnity Co.
"National Engineer"
Mason Regulator Co.
Quaker City Rubber Co.
United States Graphite Co.
American Steam Gauge & Valve Mfg. Co.
New York Belting & Packing Co.
L. Sonneborn Sons, Inc.
"Southern Engineer"
Crane Valve Co.
Economy Fuse & Mfg. Co.
Engineering & Supply Co.
Durabla Mfg. Co.
Wm. M. Wheeler
Clement Restim Co.
Strong, Carlisle & Hammond Co.

SOCIETY NOTES

The 15th annual outing of the New York Association James Watt No. 7, N. A. S. E., will take place on Sunday, Aug. 3, at Douglaston, Long Island. The main feature will be a genuine Long Island clambake. Every member of No. 7 has appointed himself on the executive committee and a good time is, therefore assured.

The Combined Engineers' Associations of Cleveland and Northern Ohio will hold their second annual picnic and outing on July 20, at Luna Park. There will be motor races, baseball and athletic sports, a prize drawing for engineers and their wives, and "prizes for everybody and a good time for all." The members of the executive committee are: H. J. Baier, W. Chas. Clarke, Thos. W. Roberts, Albert Ihlenfield, Geo. P. Klasgye, Daniel Robinson, Edward Guentzler and Thos. B. Eaton.

The summer meeting of the American Society of Heating & Ventilating Engineers, which is to be held in Buffalo on July 17, 18 and 19, promises to be most interesting and instructive. Several papers are now in hand and these, combined with the tests to be conducted during the session at the Bureau of Thermal Research, will place the members in possession of considerable valuable data. The committee on tests has arranged to conduct tests of piping systems and heating boilers, also a special test of fan blast heaters in connection with a paper discussing the relative efficiency of pipe coils and fan-blast heaters. In all probability there will be a paper explaining the use of charts for determining the sizes of pipes for gravity hot-water heating systems; one on the time element in heating apparatus; another comprising a report of the work on ventilation conducted by Prof. Frederic Bass at the University of Minnesota, and another on some phase of the work of the ventilation department of the Bureau of Health, Chicago. There will also be a paper discussing the loss of pressure due to elbows in the transmission of air through pipes.

DELEGATES AND GUESTS AT CONNECTICUT N. A. S. E. CONVENTION

Hotel Statler has been selected as headquarters. The sessions, with one exception, will be held in the convention hall of the hotel. The first session will be convened at 10 o'clock, a.m., July 17. There will be an afternoon session on the same day, forenoon and afternoon sessions on July 18, and a forenoon session on July 19. The committee on entertainment promises that those attending may look for diversions of an unusually attractive nature.

New York engineers will hold outings on Sunday, July 20, No. 23, N. A. S. E. outing, at Eitners, Grant City, Staten Island. Sunday, Aug. 3, No. 7, N. A. S. E. outing at Bartletts Inn, Douglaston, L. I. Sunday, Aug. 10, No. 44, N. A. S. E., outing at Eitners' Grant City, Staten Island. Sunday, Aug. 17, Phœnix outing at Donnelly's, College Point, L. I. Sunday, Aug. 24, Blue Club, of Newark, N. J., outing at Olympic Park, Newark, N. J.

PERSONALS

George Westinghouse was awarded the Grashoff gold medal of the Society of German Engineers at the annual meeting of the society at Leipzig on June 23.

President Charles A. Coffin, after more than thirty years' service with the General Electric Co. and its predecessors, has retired, and has been succeeded by Edwin W. Rice, Jr., senior vice-president of the company. Mr. Coffin will remain chairman of the board of directors.

M. J. Kehoe has been appointed electrical engineer of the Ohio Electric Ry. in charge of power houses and substations, with offices at Springfield, Ohio. Mr. Kehoe was formerly connected with the Fort Wayne & Northern Indiana Traction Co. in a similar capacity for 13 years.

James H. Stretton, chief engineer of the W. H. Constable Cold Storage plant, El Paso, Tex., was married on June 18, to Miss Ruth E. McMullen, Los Angeles, Calif. Mr. Stretton was until recently engineer of the Baltimore Hotel, Los Angeles. He is a member of the National Association of Stationary Engineers.